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JOURNAL

OF THE

INSTITUTE OF ACTUARIES.

“I hold every man a debtor to his profession, from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavour themselves by way of amends to be a help and ornament thereunto.”—BACON.

VOL. XXXVI.

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JOURNAL

OF THE

INSTITUTE OF ACTUARIES.

THE DEATH OF THE QUEEN.

THE ORDINARY MONTHLY MEETING was held at STAPLE INN HALL, HOLBORN, on Monday evening, January 28th, the President, Mr. C. D. HIGHAM, occupying the chair.

The PRESIDENT (all rising and standing while he spoke) said—Gentlemen, a week ago we were assembled here in the gloom of impending trouble, and now the blow has fallen: the mother of many nations has been gathered to her rest, and the wail of a mighty grief rolls over the Empire and beyond. We actuaries are accustomed to deal with questions of life and death, and ever and anon there comes home to one or other of us the sharp reminder that among those figures of which we talk so glibly there is one that may mean all the world to the little circle in some sorrow-stricken home. But now, not this one or that, but everyone alike is oppressed by a keen sense of personal bereavement; for the dear Lady, who is to us no more, was not only the embodiment of all that is good and great, and, by her highest title, the Queen of Women—for she was never less the woman because always

the Queen—but by her gentle sway and tender pity she became, as it were, the friend of every subject she ever had. There is much that I could say, and yet never describe her worth: happily, there is nothing that I need say, for we all know what she was, and feel acutely that our loss can never be repaired. In due course the Council will lay at the foot of the Throne the Institute's respectful memorial of sympathy and loyalty, and I will not insult you by asking you to pass any resolution in the matter, for with one voice we should desire to pay this tribute as being all that is in our power. Had there been a suspicion of festivity about our proceedings we should at once have adjourned this meeting; but she whom we mourn, though she owed no fealty to any monarch save the King of Kings, was ever the servant of duty, and we conceive that we shall best follow her priceless example by continuing our work, bearing ever on our hearts in reverent memory the unfading blossom of that noble life. And withal, gentlemen, we shall keep in remembrance the august family now so bitterly bereft, and especially him who has taken up the burden she bore so long, and will carry it, through sunlight and the passing shadows, along the path of Duty pointed out by her guiding hand. None are more loyal than we actuaries, though there are millions and millions as loyal as we, and we will bear him true allegiance and to the extent of our ability support all his efforts as, according to his own royal words, he devotes his life to his people's good. In loyalty, then, and in duty we go on our way, with the twin prayer—sometimes on our lips, always in our hearts—"God rest her Majesty!" "God save the King!"

*The following is the Memorial dutifully offered to the King,
which is referred to in the speech of the President.*

TO THE KING'S MOST EXCELLENT MAJESTY.

MOST GRACIOUS SOVEREIGN,

We, your Majesty's loyal and dutiful subjects, the President, Council and Members, of the Institute of Actuaries, humbly approach your Majesty with the expression of our profound grief at the loss which all your Majesty's subjects have sustained by the death of our beloved Sovereign, QUEEN VICTORIA, ever to be borne in reverent remembrance.

Her late Majesty was pleased to grant to The Institute of Actuaries a Royal Charter of Incorporation, and in this gracious act of favour we recognized her Majesty's fostering encouragement of all efforts to promote the welfare of her people; and her priceless example will ever stimulate us to develop and extend actuarial science for the benefit of provident institutions and the good of the nation at large.

We most respectfully offer to your Majesty, to our gracious QUEEN ALEXANDRA and to the Royal Family, our heartfelt sympathy. We venture further to present to your Majesty our homage and obedience, with our humble congratulations upon your Majesty's accession to the Throne, praying that your Majesty's reign may be long and glorious.

Given under the Common Seal of the said Institute at
Staple Inn Hall this twelfth day of February
in the year of our Lord one thousand nine
hundred and one.

C. D. HIGHAM, *President.*

ERNEST WOODS } *Honorary*
F. SCHOOLING } *Secretaries.*

L.S.

THE following gracious acknowledgment of the foregoing Memorial was read by the President at the meeting of the Institute on 25 March 1901, all standing:—

HOME OFFICE, WHITEHALL,

20 March 1901.

SIR,—I am commanded by the King to convey to you hereby His Majesty's thanks for the Loyal and Dutiful Address of the President, Council, and Members of the Institute of Actuaries, expressing sympathy on the occasion of the lamented death of Her late Majesty Queen Victoria, and congratulation on His Majesty's Accession to the Throne.

I am, SIR,

Your obedient Servant,

(Signed) CHAS. T. RITCHIE.

C. D. HIGHAM, Esq.,

Institute of Actuaries,

Staple Inn, Holborn, W.C.

On the Rationale of Discounted-Bonus Premiums. By HENRY MOIR, F.I.A., F.F.A., of the Scottish Life Assurance Company. Being the Essay to which a Prize, presented by Mr. James Chisholm, was awarded.

[Read before the Institute, 31 December 1900.]

INTRODUCTORY.

THIS subject was ably dealt with in 1894 by Mr. G. F. Hardy (*J.I.A.*, xxxi, 261), who submitted suitable methods and formulas for the calculation of premiums, and dealt with other practical points, such as the treatment of these policies at a valuation. The article and the discussion constitute a most valuable contribution to the science of life assurance: accordingly in the following essay it is proposed to avoid the repetition of questions which were then fully discussed, and rather devote attention to the application of the system.

Origin of Discounted-Bonus Policies. Discounted-bonus policies were first introduced by a Scottish Office in the year 1854, when it was stated that the new rates were "founded on a deduction of an annual "value equivalent to an assumed bonus of $1\frac{1}{2}$ per-cent." The following rates per £100 were then adopted:—

Age	Full Rates	Discounted Bonus Rates	Difference
	£ s. d.	£ s. d.	£ s. d.
20	2 2 1	1 8 6	0 13 7
30	2 11 9	1 16 7	0 15 2
40	3 8 2	2 9 7	0 18 7
50	4 9 1	3 10 9	0 18 4
60	6 6 4	5 7 2	0 19 2

These unusually low rates were defended on the ground that the select 4 per-cent net premiums were found to be £1. 7s. 11d., £2. 7s. 5d., and £5. 6s. 5d. for ages 20, 40, and 60 respectively ; and as the office earned much more than 4 per-cent on its funds, conducted its business with economy, and derived a considerable profit from other sources, the position was logically and satisfactorily upheld. During the years that have since elapsed the bonus has not once fallen below the rate then anticipated. The manager, when first reporting the scheme at an annual meeting, wisely added :—

“Even assuming that these rates were adapted for this generation, we know not, in the dispensation of Providence, what greatly increased mortality may yet be experienced in the history of an office like this ; and therefore I think you will agree with the directors in considering that it was essential, in the adoption of such reduced rates as a choice to the public, to establish them also on the foundation of our old rates by the simple expedient of making the sum vary according as the additions may fall short of, or go beyond, the rate of 1½ per-cent.”

It is interesting to note that mortality was viewed as the principal element of uncertainty. Further and riper experience has proved that this element is probably the least dangerous. The low rates above quoted were retained by the office for about 30 years, but were then considerably increased, the additions being great at the older ages.

Age	Full Rates	Discounted Bonus Rates	Difference
	£ s. d.	£ s. d.	£ s. d.
20	2 2 1	1 12 0	0 10 1
30	2 11 9	1 19 0	0 12 9
40	3 6 3	2 12 0	0 14 3
50	4 10 1	3 13 0	0 17 1
60	7 0 0	6 0 0	1 0 0

The principle involved in such policies was afterwards adopted by a Canadian company, and introduced in a modified form by one or two home offices. Little more was heard of it until a few years ago, when it appeared as a prominent feature in the prospectuses of several British life offices. This attempt to grant protection against premature death at the lowest possible rate of premium has now assumed considerable proportions, and the rapid development is probably one of the many evidences of keen competition for business. The regulations affecting the grant of such policies must, of course, be modified so as to harmonize with the system of distribution followed by any particular office. It is unnecessary to enter into details of the practice of individual offices, because members of the Institute are already conversant with the schemes which have been submitted to the public; accordingly attention will be directed mainly to the bonus system known as the "Uniform-Reversionary", which may be said to occupy a position about midway between the Cash and the Compound-Reversionary Bonus Systems. The arguments stated for and against the one system may be readily adapted to all others.

General scope
of Essay.

In submitting the following remarks, the intention of the writer is twofold: firstly, to look fairly and without prejudice at the advantages, disadvantages, and difficulties which attend the Discounted-bonus System, and would present themselves to a careful actuary who might contemplate the introduction of such a scheme into his office; and, secondly, to treat the question from the point of view of an actuary who may be called upon to deal with some such scheme already established. These main questions can only be treated generally, as references traceable to individual offices are considered undesirable; but the system of analysis hereinafter submitted may be readily applied to the circumstances of any particular office in a more complete manner than that adopted in this paper, seeing that the actuary in charge would be in the position of acquiring full information under the different heads. Premiums approximating to those charged in practice have been deduced from a small group of selected offices by taking the arithmetic mean of their rates. The group consists of those offices which appear to have discounted bonuses at a rate exceeding a Uniform Reversionary Bonus of 30s. per-cent per annum, so that, while the average rates are not absolutely the least which are charged, they nevertheless approach the lowest limit of premium rates in this country.

Practice of
Offices.

The rate of bonus anticipated differs widely in different offices, but ranges from 20s. per-cent to 40s. per-cent per annum of Uniform-Reversionary Bonus. In most cases the reason for the adoption of any specified rate appears to be that the past experience of the office (it may be for 25, 50, or even 75 years) has been so satisfactory that no lower rate has been declared, and the assumption is tacitly made that the future is likely to reflect the past. Where the past experience has been accurately examined, and it is found that the profits have been derived from sources which remain unimpaired, and will continue to yield similar returns (subject only to natural fluctuations), then the assumption referred to is legitimate; but if some of the sources from which the profits of the past have been realized are likely to prove barren in future, then it behoves actuaries to exercise great caution in entering into contracts which are likely to endure for periods ranging up to 60 or 70 years. Where so great a diversity exists in practice between the assumption of bonuses at 20s. and bonuses at 40s., there is room for much difference of opinion as to the merits and demerits of the system. It will be interesting to trace the past experience of the selected group of offices in order to see whether the future gives promise of the same prosperity as they have undoubtedly enjoyed during the past. As an overwhelming proportion of life assurance business is effected between the ages of 25 and 50, it will be sufficient for purposes of comparison to make use of the two ages 30 and 45 in examining premium rates, and tracing the monetary effects of changes in the mortality.

In order to obtain figures with which to make comparisons, let it be assumed that full-profit premiums have been computed by Sprague's Select Tables at 4 per-cent interest by the formula

$$1.05 \left(\pi'_{[x]} + \frac{.01}{a_{[x]}} + .00125 \right)$$

Where π' represents the pure premium to assure 1, with a uniform reversionary bonus of £1. 2s. 6d. per-cent per annum, and interim bonuses at the same rate. It will be found that this formula produces premiums approximating closely to the average rates of the Offices in the group. In order to deduce Discounted-bonus Premiums, the annual equivalent of the anticipated bonus, based on an investment rate of interest, should form a deduction from the full profit rate. Such deduction should be computed by Select Mortality Tables, even although the original rates may have been based on an

aggregate table such as the H^M , or, for that matter, on the Carlisle or Northampton Tables. Select Tables give the most probable rates of mortality for the future, and will therefore measure the discounted bonus more precisely amongst lives medically examined. Assuming, further, that an annual bonus of 35s. per-cent is discounted at $4\frac{1}{2}$ per-cent interest, the formula for the reduced premium will be :

$$1.05 \left(\pi'_{[x]} + \frac{.01}{a_{[x]}} + .00125 \right) (4\%) - \frac{.0175 R_{[x]}}{N_{[x]}} (4\frac{1}{2}\%).$$

The following tabular statement shows how these calculations work out :—

Age	FULL PROFIT RATES		DISCOUNTED BONUS RATES		Net Rate Select 3½ per-cent	Non-Profit Rate by Sprague's Formula
	By Formula	Average of Offices in Group	By Formula	Average of Offices in Group		
30	£ s. d. 2 10 1	£ s. d. 2 10 2	£ s. d. 1 16 4	£ s. d. 1 17 2	£ s. d. 1 16 3	£ s. d. 2 0 9
45	3 16 11	3 16 5	2 19 2	2 18 8	2 19 6	3 5 5

Advantages of the System. In the early years of life assurance, premium rates ruled high. This arose partly from the conservative methods by which they were calculated, but in a greater degree from the faulty construction of the Northampton and other ancient mortality tables, which were, moreover, deduced from population statistics, and not from the records of selected lives. Accordingly, large profits were earned by the old offices, and it became the custom, although it was no part of the original scheme, to return a portion of the surplus to policyholders by way of bonuses. This was the natural treatment of the surplus, seeing that the first offices were formed on the mutual principle, and it agreed so well with the popular idea of what was equitable and right, that there have been but few attempts to revert to the original intention. It was soon necessary to grant assurances at lower rates without profits, but the experience of many years has proved to the public that the more economical plan in the end is to take a with-profits policy in any sound office, paying the higher premium and securing bonuses. The public are therefore prejudiced in favour of the Discounted-bonus System, because it allows them the privilege of participation, while at the same time calling for premiums in some cases nearly as low as, and in others much lower than, the corresponding non-profit rates. While, therefore, the system is a departure from the sound and well-tried

method of deducing premiums from the rates of mortality, interest, and expense likely to be experienced, nevertheless, the new rates are accurately computed on a scientific basis. Should they prove inadequate in future, the offices are protected against loss by the power which is in most cases reserved to modify either the premiums or the sums assured.

It is evident that any business man who can only afford a limited expenditure in life assurance premiums, or who may be in the position of advantageously employing all his available capital in commercial pursuits, may secure the protection he desires by the discounted bonus method, his initial assurance being even greater than under a non-profit policy. He does not sacrifice his right to benefit from the prosperity of the office, and he may reasonably argue that his business will produce to him a sufficient capital for his future requirements, protection against the risk of early death being all that he requires meantime.

Moreover, life offices have in recent years experienced some little difficulty in obtaining remunerative investments. The excellent securities which might formerly be purchased to yield 4 or $4\frac{1}{2}$ per-cent have now risen so greatly in price that they yield only about 3 per-cent. If, then, the office may avoid the necessity for investing and accumulating the heavier premiums for with-profit policies, and may thus retard the rapid increase in the funds, the management of the office will be simplified. Further, the method by which the deduction from the full rates is arrived at is practically equivalent to the assumption that these deductions are invested at $4\frac{1}{2}$ per-cent interest, and secured against the surrender values of the policies. This is a desirable condition, seeing that the investment of the constantly increasing life assurance funds has been causing much anxiety. The expense incurred in obtaining and supervising investments will be sensibly diminished, while it may be said that the assumed rate of interest is earned without any deduction for income-tax. Yet it is somewhat paradoxical to observe that the rapid increase in discounted-bonus policies is concurrent with a strongly marked development in endowment assurances, where exactly the opposite principle is involved. Doubtless the two classes of policy appeal to different sections of the community.

Another advantage of the system is that, lower premiums being charged, the commission expenses for collection are likely to be slightly less than those affecting assurances at full rates. Thus, if the expenses amount to 5 per-cent on the premiums, a saving of 8*d.* per-cent (*i.e.*, 5 per-cent on 13*s.* 9*d.*) will be

effected on each premium at age 30, and 11*d.* per-cent at age 45. This saving represents nearly 2 per-cent on the discounted bonus premiums, and would increase the bonus earned by about 1*s.* 8*d.* per-cent. The renewal charges may thus be lighter than those affecting full premiums; but it is unlikely, though very desirable, that the initial charges will be generally curtailed.

While these advantages are apparent and real, there are disadvantages lurking under the system, some of which are not so readily observed.

Disadvantages of the System. The premium income of an office transacting much of this business is either reduced or kept at a lower figure than it would otherwise attain. While the renewal commission expense might perhaps be lighter, it must be borne in mind that the ratio to premium income would remain as before, and the fixed initial charges for office expenses, medical fee, policy stamp, &c., would prove a heavier burden when set against the smaller premiums. There is also a section of renewal expenditure quite independent of the rate of premium, and it would weigh more heavily against this class of policy. The trifling advantage previously mentioned is probably more than balanced by these drawbacks.

Lapses. The increasing tendency to allow policies to lapse after one or two years gives evidence of unhealthy competition in life assurance. If a discounted-bonus policy be allowed to lapse, it is clear that the office loses more (or gains less, if it contrives to earn true profit from lapses) than it would under a full-profit policy, because the premium received is so much smaller, while the risk incurred is practically the same. Information regarding the lapse rate in Great Britain cannot be obtained from any public source; but companies in the United States have to render full particulars of the business passing off their books. Unfortunately, the experience in the United States in this respect is of little value to a British actuary, because the conditions of business are so essentially different, and the lapse rate so strikingly high. The ratio of lapses to new business in one of the giant American companies may, however, be of interest as showing the probable limit to which this evil influence might grow. The average yearly amount of lapses in a period of three years was about £14,000,000, while the average new business for the same period was about £26,000,000, the former representing 53½ per-cent of the latter. If, on an average, 1¼ premiums were paid under each lapsed policy under the discounted-bonus plan,

then the loss of premium, when compared with the same amount of lapsed policies at full rates, would be 17*s.* 2*d.* per-cent ($1\frac{1}{4}$ times 13*s.* 9*d.*) on the sums assured effected at age 30, and £1. 2*s.* 2*d.* per-cent at age 45; and if the lapses in a British company under its discounted-bonus policies were to reach even 25 per-cent of the new business, then the average loss would be about 5*s.* per-cent over the whole. Some steps should be taken so as to avoid such loss, and the fittest course would appear to be to reduce the initial commission. A reduction from £1 per-cent to 15*s.* per-cent would just about balance the loss on lapses if the assumptions already stated conformed to the experience of the individual office concerned. Twenty-five per-cent is doubtless too high a ratio of lapse for any well-conducted office, but the actual ratio is probably increasing, and it is always greatest amongst policies effected at low rates of premium.

The disadvantages already referred to are of comparatively little importance, and steps may be taken to counteract them. But there is a more serious risk in the case of some offices which have forestalled the full rate of bonus they have declared during recent years: it is that the future may prove less favourable, that bonuses may be reduced with the consequent restriction in sums assured or increase in premiums, and that public confidence in actuarial methods may thus be shaken. The prospectuses of offices putting forward such schemes state, more or less clearly, that the sums assured will be diminished or the premiums increased, in event of the future bonuses falling below the estimated rate. This statement is generally accompanied by one to the effect that for many years past the bonuses have equalled or exceeded this rate; and a remark is carefully prefixed, pointing out that any bonus beyond the rate discounted will be added to the policy or applied to reduce the premium still further. While, therefore, there is evidently no intention to mislead, yet many policyholders do not understand, and have never had explained to them, the risk of their contracts being modified in future years. Some of them have even been informed that their policies are "with profits", and, on account of the inherited prejudices already referred to, think that the benefit secured is greater than that under a policy without profits, never dreaming that the sum assured is not guaranteed. If the explanations regarding such policies were given in all cases by trained officials, there is little doubt but that educated policyholders would understand the nature of the transaction,

but in many cases the agent introducing the proposal has himself little knowledge of the discounted-bonus policy, and accordingly the person proposing is not rightly informed.

LIKELIHOOD OF BONUS RATES BEING MAINTAINED.

In order to arrive at a fair estimate of future bonuses it is necessary to analyse the sources of surplus and find out whether their productiveness is likely to remain the same. Bonuses depend upon:—

- (1) Premiums charged.
- (2) Interest realized.
- (3) Expense incurred.
- (4) Mortality experienced.
- (5) Profits derived from miscellaneous sources, such as Surrenders, Lapses, Non-profit Business, Annuities, Re-assurances, Realization of Investments, Interest on Reserve Fund, &c.

The first three causes may be traced accurately during the last 30 years from the Board of Trade Returns; and also the item relating to profit from investments in those cases where such profit is credited separately. General reasoning may be applied to the other causes, but statistical demonstration of such reasoning may not easily be procured.

Premiums. All the Offices in the selected group were in existence when “The Life Assurance Companies Act, 1870” came into force. Their average rates of premium as given in the first Board of Trade Returns, and in the latest returns, are shown in the following statement:—

	WITH PROFITS		WITHOUT PROFITS	
	Age 30	Age 45	Age 30	Age 45
First Return, 1870	£ s. d. 2 10 7	£ s. d. 3 16 1	£ s. d. 2 4 4	£ s. d. 3 8 9
Latest „ 1898	2 10 5*	3 16 9*	2 0 10	3 5 1
Difference =	-0 0 2	+0 0 8	-0 3 6	-0 3 8

* These rates differ fractionally from the latest prospectus rates given on page 8.

The with-profit premiums have therefore remained practically unchanged, but the non-profit rates have been seriously reduced.

While, therefore, with-profit policies, so far as rates of premium are concerned, contribute much the same as before, it is evident that a smaller profit than formerly will be derived from the non-participating policies. This is what might reasonably be expected. The means of accurately gauging the risk incurred under each contingency is being constantly improved, and competition forces offices to accept the smallest premium which can be made remunerative. The tendency towards reduction in these rates is already apparent, and, when the new experience is made public, the rates of other offices must sooner or later follow the course already adopted by some of the progressive offices. It is difficult to place any monetary value upon the effect which the smaller profit from this source may have upon future bonuses. The influence must be very gradual, and the full effect will not be in operation until all the policies running at old rates have been replaced by new assurances. Moreover, in some companies any profit arising from this branch of the business is taken exclusively by the shareholders, so that the bonuses to policyholders are not affected by changes in non-profit rates. The ratio of the total without-profits business to that of the participating class is only about 1 to 5, so that the influence of a reduction in the premiums charged under the former must in the meantime be trifling. That influence is, however, in the direction of reducing the surplus available for distribution, and it is likely to become more important in future—especially as the reduced premiums are likely to attract a greater share of business to that branch.

Interest. The average rate of interest realized by the selected group of Offices, deduced by Hardy's well-known formula (after deducting income tax), appeared in the first returns as £4. 9s. 6d. per-cent. In the latest returns the average rate is only £3. 13s. 9d. per-cent. Profit on investments may, however, fairly be viewed as a means of increasing the interest yield, and when the exceptionally large profits shown in the last returns are included, the rate of interest works out at £4. 1s. 6d. per-cent. Reliance should not, however, be placed upon such profit, because there is certain to be serious fluctuation, as the course of the Stock Exchange during recent years clearly proves; and the items of profit which have so freely appeared during the past five years may quite possibly disappear, or even be changed into loss during the next quinquennium, if the present low range of prices and values should continue. Even when such profit is taken into account it will be seen that the rate of interest has declined by

8s. per-cent, while if profit from investments be neglected the reduction is actually more than 15s.*

This decline in the return from investments is not by any means exceptional to the Offices selected, for the same feature is apparent if the average of British Life Offices be taken. Mr. David Paulin in a paper on "Life Office Investments", read before the Actuarial Society of Edinburgh in 1894, submitted in a useful form the average rates of interest realized since 1870, and his schedule is here partly reproduced, the further experience during the last five years having been added so as to bring the information up to date.

Average Rates of Interest realized by the principal British Life Offices.

Year	Average Rate of Interest (less Tax)	INCOME TAX		Estimated Interest before Deduction of Tax	Profit on Investments (after deducting Loss)
		Rate	Amount (say)		
	£ s. d.	d.	s. d.	£ s. d.	s. d.
1870	4 9 5	5	1 10	4 11 3	...
1875	4 10 5	2	0 9	4 11 2	...
1880	4 7 3	6	2 3	4 9 6	...
1885	4 4 8	6	2 2	4 6 10	...
1890	4 1 11	6	2 1	4 4 0	3 5
1891	4 2 1	6	2 1	4 4 2	0 4
1892	3 19 10	6	2 0	4 1 10	1 2
1893	4 1 1	6	2 1	4 3 2	0 7
1894	4 0 0	7	2 5	4 2 5	1 8
1895	3 18 6	8	2 8	4 1 2	1 6
1896	3 17 2	8	2 8	3 19 10	2 5
1897	3 17 8	8	2 8	4 0 4	0 6
1898	3 16 3	8	2 7	3 18 10	1 0
1899	3 15 5	8	2 7	3 18 0	3 8

The percentage of increase in realized value of investments has been added during the later period as having a distinct bearing upon the true return. It is a significant fact that the profit from investments is greater in those years which show a reduced rate of interest.

The rate of interest is less, by more than $\frac{1}{2}$ per-cent, than what it was 20 years ago. This probably means a decline in the Uniform Reversionary Bonus of at least 5s. per-cent per annum—a somewhat serious matter. It will be observed that the

* These calculations were made from the last Board of Trade Returns deposited during the year 1898. More recent accounts of the Offices in the group show an average rate of interest of £3. 12s. 10d. per-cent, and profit from investments of 2s. 9d. per-cent, making £3. 15s. 7d. per-cent in all. It may further be remarked that one office with larger funds than any of the others earned over £3. 18s. per-cent, and this had considerable effect in maintaining the average.

decline has been steady and continuous. Whether the same course may run into future years it is impossible to foretell. The present economic conditions point to higher rates in prospect, but this feature may only be of a temporary character. The steady decline in interest has been aggravated by increased income-tax; and there seems at present little chance of relief in that quarter.

Expenses. Turning to expenses incurred, it is found that the average in 1870 of the Offices in the group was $9\frac{3}{4}$ per-cent of the premium income; but in 1898 this percentage had been increased to $12\frac{1}{2}$. This higher ratio may have been partly brought about by the transaction of increased new business, for it is found that the premium income of the offices has nearly doubled in the 28 years. The expansion in business of these offices has not been exceptional, for the premium income of the aggregated Life Offices of Great Britain has also been nearly doubled. It is generally thought that the expenses—especially for commission to agents—have increased even after full allowance has been made for the initial charges in procuring the larger volume of new business; and if the increased expenditure be of a permanent character, it becomes of interest to see what the monetary effect on the bonus rate may be. At age 30 an extra expenditure of $2\frac{1}{2}$ per-cent on the full premium means that 1s. 3d. per-cent less will be available for bonuses, and this is the present value of a bonus of 2s. 11d. per-cent per annum. At age 45 such permanent extra cost represents bonus at the rate of 3s. 6d. per-cent; so that on the average probably $2\frac{1}{2}$ per-cent of increased outlay will mean a reduction in bonuses of over 3s. per-cent.

Mortality. A considerable amount of profit has doubtless been earned through the rates of mortality having decreased, or the selection of lives being now more efficient than formerly. The H^M statistics, on which recent calculations of premiums and reserves have generally been based, were spread over a long period terminating in 1863; and, while the constitution of the physical frame cannot have changed materially even since the beginning of the century, nevertheless, medical, and more particularly sanitary, science have made rapid strides. Accordingly, assured lives may now be selected with greater discrimination, while improvements in sanitation have minimized the risk of plague epochs, and have in other respects enhanced the value of life in the large cities whence so many proposals are drawn. This improved rate of mortality might then provide part of the future bonuses of life offices. The new Joint Investigation into the mortality from

1863 to 1893 will throw some light on this subject ; but full statistics have not yet been published. The writer has, however, been able to refer to a simple graduation of the l_x column of the New Experience, and although the aggregate form is not suited to such investigations, still, general conclusions may perhaps be arrived at. Taking, as before, the principal insuring ages, 25 to 50, it is found that the new figures at 4 per-cent, as compared with the old, are as follows :—

Age	4 PER-CENT ANNUITY-VALUES		4 PER-CENT ANNUAL PREMIUMS PER £100			Bonus purchased by Difference
	New	HM	New	HM	Difference	
25	18·350	17·961	1·322	1·428	·106	·266
30	17·442	17·130	1·576	1·669	·093	·215
35	16·433	16·197	1·890	1·969	·079	·168
40	15·306	15·135	2·287	2·352	·065	·128
45	14·050	13·901	2·798	2·865	·067	·122
50	12·666	12·536	3·471	3·542	·071	·120

These figures point to the conclusion that during the past 30 or 40 years reversionary bonuses of 3s. or 3s. 6d. per-cent have been earned through the Mortality Experience having been more favourable than that on which the rates of premium and reserves were based. This is a source of profit which we have every reason to expect may be maintained and even improved upon. The general statistics deduced from all the assurance offices may not however represent the mortality affecting any individual office ; and it is quite probable that, in those cases where selection is really strict, even lighter mortality may have been experienced and consequently additional profits earned. A cursory glance at the new annuity-values indicates that larger reserves will be required ; but a careful analysis would be necessary in order to tell the full extent of this feature. Any needful addition to reserve would of course have to be drawn from the surplus in the early future.

There is, however, another phase of the mortality question to be observed when the subject of discounted-bonus policies is under consideration. It has been pointed out time after time that the rate of mortality bears some relationship to the rate of premium paid. When a high rate of premium is paid the mortality is light, while heavier mortality seems to affect those policies taken out at lower rates. Thus the low death rate has been a feature in the case of endowment assurances, as shown by

several American and Colonial experiences, and currently reported regarding the new unpublished results. If a proposer has a feeling of uncertainty regarding the likelihood of his living to a good age, he will naturally desire to effect as large a policy as possible by paying a low rate of premium. The Discounted-bonus System affords a most suitable means for such selection, adverse to the office. Accordingly, the deductions above referred to, based upon an aggregate table including endowment assurances, may not be trustworthy when applied to discounted-bonus policies. It is not unlikely that the rates of mortality now found to prevail amongst non-profit and other low-rated policies in the New Experience may be quite equal to those deduced by Dr. Sprague from the H^M statistics, notwithstanding the improvement in the aggregate mortality.

General Conditions. The conditions of assurance have been growing more and more liberal in recent years. Early in the present century, an extra premium was charged for crossing to the Continent of Europe, and even for the short sea voyage to Ireland a special license was often necessary. In more recent years, it was the practice to charge an additional premium, commensurate with the extra risk, should the life assured proceed beyond the limits of Europe within the first five years of the assurance. The regulations differed, and still differ, considerably; but there is now a disposition on the part of offices to remove all unnecessary restrictions and grant world-wide policies from the commencement, in the absence of any intention to engage in a hazardous occupation or to proceed to an unhealthy climate. This tendency is in the right direction, and policies from which restrictive conditions are absent are an undoubted boon to the assuring public. It is to be expected, however, that the extra premiums receivable will have fallen during the past 30 years, and this is found to be the case in a marked degree. In the first valuation returns, the extra premiums of the selected companies amounted to about £4,870, or .8 per-cent of the ordinary premiums; but according to the latest available returns, this item has fallen to £3,750—less than .35 per-cent of the ordinary premium income. The extra risk attendant on foreign travel and residence is less now than before, so that, as the sum involved is small, the monetary effect of the changed conditions will be almost inappreciable. The more liberal spirit of the time has, however, developed in other directions, which may affect the profits earned. Policies which have acquired a fair surrender-value seldom lapse,

as they formerly did, through non-payment of a premium; and the surrender-values now paid approximate more nearly to the true reserve-values of the assurances. The increased sympathy shown towards policyholders in these several directions must, to a certain extent, reduce the available surplus, but it is probable that any such reduction is counterbalanced in proprietary companies by the reduced proportion of the surplus now taken by shareholders. Mutual offices do not, however, possess this set-off: the removal of restrictions and extras will therefore be made at the expense of the general body of policyholders.

Annuities. The prices charged by offices have in recent years been greatly increased, and it is likely that this class of business will in future be made profitable. An estimate of the probable profit might be roughly made in the case of any individual office, but this would be of little use for the present investigation. It is sufficient to mention the subject in passing.

Summary. The foregoing particulars point not only to the possibility of a reduction in bonus rates, but even to such a contingency being likely. Profit premiums being about the same, the only sources which point to the maintenance of past results are:—

- (1) Light mortality;
- (2) Smaller proportion of surplus taken by proprietors, and
- (3) Annuities.

On the other hand, the factors pointing towards a reduction in bonuses are:—

- (1) Reduced interest;
- (2) Increased expense;
- (3) Lower non-profit rates;
- (4) Increased liberality in:—(a) foreign residence without extra, (b) non-forfeiture regulations, (c) surrender-values, &c.

GENERAL DEDUCTIONS.

There are many undoubted advantages to be gained by the issue of discounted-bonus policies; but in some of the schemes put forward there is a dangerous likelihood that the anticipated bonus may not be sustained. This would be a most unfortunate occurrence both for the office and the policyholder. The latter

would find his sum assured gradually diminishing with each "distribution of surplus", and he would not be slow to inform his friends of the full irony of that expression. It is contrary to all the traditions of British commerce to sell below cost price, and yet this attempt is apparently being made by several assurance offices. Some instances of selling below cost have been noticed in commercial enterprise, especially when a powerful and wealthy firm or syndicate tries to crush out some weaker rival and secure a monopoly. Apart altogether from the questionable morality of such proceedings, life offices are still too numerous and too widely extended in their operations to fear that any one giant company may obtain a monopoly. Accordingly, an attempt of this nature must recoil disastrously upon the office making it. Our president, in explaining how premiums should be charged, remarked:—"The company, like an ordinary trader, charges a price which will cover the prime cost of the article, the expenses of management of the establishment, the profit which it hopes to make out of the transaction, and a little extra for contingencies." Some old and wealthy offices, with great accumulated funds, may doubtless from their past earnings maintain a good rate of bonus for many years to come; but the adoption of the discounted-bonus scheme in its extreme form introduces a greater proportion of participators, so that the share accruing to each will be necessarily reduced. So far back as 1829 this possibility was observed by the policyholders of one assurance institution, and their opinion was reported as follows:—"Several of the more sober-minded in the General Court were clearly of opinion that some measures should be devised to check the too rapid accession of new members, and to prevent them, by their unlimited and overwhelming number, from absorbing the greater part of a surplus to which they had never contributed." Policyholders who adopt the discounted-bonus plan would doubtless in other circumstances have effected non-profit policies, or full-profit policies of reduced amount, so that the share of the general surplus taken by them would be smaller. Accordingly, any wealthy office with a large undivided surplus, particularly if on the mutual principle, can have little to gain by discounting a rate of bonus equal to that actually earned.

Moreover, it is all but impossible to preserve strict equity between two classes of participating policyholders, unless their funds, investments, bonuses, &c., be kept rigidly apart. The difficulties attendant on the questions of reserve and surrender-

values will be afterwards referred to; but, in addition to these, there are several other points deserving careful consideration, namely:—

- (1) The question of the basis on which the deductions should be computed. There seemed to be fair unanimity amongst actuaries that the deductions should be calculated at not less than $4\frac{1}{2}$ per-cent, although the earning even of 4 per-cent is becoming a thing of the past. The adoption of the higher rate takes too much from the discounted-bonus policyholder.
- (2) Each fluctuation in the rate of interest must alter the ratio of contributions to surplus made by the full-profit and discounted-bonus policyholders respectively.
- (3) It is probable that the rates of mortality in the two classes will differ—it may be materially.
- (4) The strain of initial and renewal expenditure in the two classes of policies is entirely different.
- (5) There was much difference of opinion in 1894 even between our highest authorities as to whether compound bonuses should be anticipated. The question was viewed from two standpoints, and each seemed right from his own point of view. It will generally be felt, however, that the discounting of a compound bonus of K entitles the policyholder to a greater reduction than the discounting of a simple bonus of the same amount. Otherwise, if he had the requisite skill, he would patronize some office where a simple bonus of $(K + S)$ was discounted, such simple bonus being just equivalent to a compound bonus of K .

How, then, can we reconcile all these conflicting elements and allow the two classes to participate equally in the bonuses? The same difficulties arose in connection with endowment assurance policies, and even yet some offices guarantee a fixed bonus to such, or make a separate investigation of the profits. In other offices it is well known that injustice is done to one or other of the two bodies of policyholders: at best only rough justice can be meted out. Premium rates should be so consistent one with another, that it becomes immaterial to an office which table or

which scheme may be selected by a proposer. They should all be remunerative in a degree equal to the risk; but this would not be so if the without-profit premiums were considerably higher than the discounted-bonus premiums. It is difficult to get rid of the fundamental axiom that the "cost price" should in all cases be the basis on which premium rates are fixed, and the transaction of business at pure $3\frac{1}{2}$ per-cent or even 4 per-cent select rates, when only $3\frac{1}{2}$ per-cent is being earned, seems highly dangerous.

Would it not be much better that each office should have one class of participating policyholders, and one only? They might pay high premiums and take the risks of fluctuation, guaranteeing the sums assured in all cases. The advantages of the discounted bonus scheme might still be retained, but if the sum assured were guaranteed, the actuary responsible would make a cautious estimate for the future, and discount bonus at a rate not higher than about 20s. per-cent. For the guarantee of the sums assured the full-profit policyholders would be entitled to some recompense, and this might be arranged either by leaving a margin between the bonus actually discounted and the rate above which the reduced premium policies would participate, or by the addition of a small constant loading to the premium. For example, if the formulas already given were used for full-profit policies, and if the discounted-bonus premiums were formed by deducting the annual value at $4\frac{1}{2}$ per-cent interest of a reversionary bonus of 20s. per-cent, then policyholders paying the reduced rates might participate equally with full-profit policyholders in all bonuses in excess of £1. 2s. 6d. per-cent. Alternatively a small constant, say 1s. per-cent, might be added, and participation allowed in all bonuses exceeding 20s. per-cent. The sums assured and declared bonuses might then be guaranteed by the office—*i.e.*, by the full-profit policyholders, for it is only in extreme cases that the proprietors' guarantee becomes operative.

Further, if effect were given to the present tendency to reduce the premiums for non-participating business, in view of the decreased rates of mortality now experienced, it would be found that the three classes of policies would be quite consistent one with the other. Even if Dr. Sprague's non-profit rates were adopted, the system would work fairly well, as the following table, in which the full-profit rates are computed by the formula given on page 7, shows:—

Whole-Life Premiums per £100 Assured.

Age	Full Profits	DISCOUNTED BONUSES		Dr. Sprague's Non-Profit Rates	Non-Profit Rates, as roughly revised
		Participate in Bonuses over £1. 2s. 6d. per-cent	Participate in Bonuses over £1 per-cent [Constant of 1s. added to (3)]		
(1)	(2)	(3)	(4)	(5)	(6)
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
20	2 1 6	1 15 1	1 16 1	1 13 9	1 12 11
30	2 10 1	2 2 4	2 3 4	2 0 9	1 19 10
40	3 5 7	2 16 3	2 17 3	2 14 10	2 13 9
50	4 11 6	4 0 4	4 1 4	3 19 3	3 18 0
60	6 17 2	6 4 1	6 5 1	6 3 10	6 2 6

If a modification in the commission to agents were considered feasible, participation might perhaps be allowed in all bonuses over £1 per-cent at the rates shown in column (3).

It might be urged that, in suggesting reduced non-profit rates, the writer shows inconsistency with his previous deductions, more particularly in view of the lower rates of interest now ruling. The new 4 per-cent net premiums given on page 16 are, however, slightly lower than the H^M $4\frac{1}{2}$ per-cent rates, so that the reduction in the rate of interest has probably been nearly balanced by improved mortality. Moreover, Dr. Sprague's formula takes no account of the fact that expenses will to a certain extent be met from miscellaneous sources; and, finally, several offices are conducted on more economical lines than those set out in the formula. The selected group of offices exemplify this last statement, notwithstanding the fact that their ratio of expenditure to premiums has increased. The revised calculations might reasonably be made at $3\frac{3}{4}$ per-cent interest on the basis of the new mortality experience; and, even if the loadings recommended by Dr. Sprague were retained, this would probably mean a reduction in the premiums to those shown in column (6) above. By the adoption of such a scheme an office would retain the principal advantages already detailed, would protect the public against its own ignorance and folly, and would secure one other considerable advantage:—Presumably a proportion of such business as would otherwise have been effected at non-profit rates would be diverted to the discounted-bonus tables, more especially if the sums assured were guaranteed. This would strengthen the position of the office in adverse circumstances, for, if misfortunes

were to arise, and the bonuses to decrease to £1, then such policies would become non-participating while nevertheless producing appreciably higher premiums than the non-profit class.

It is not often that an actuary has the opportunity of framing complete tables of rates, and of offering to the public exactly those terms he may consider equitable. Accordingly, while the foregoing may give a satisfactory solution in theory to some of the difficulties surrounding the discounted-bonus schemes, nevertheless, an actuary must be prepared to view matters as they are. He must endeavour, by properly estimating the reserves, to maintain the rate of bonus which may have been anticipated, and in cases of surrender he has an opportunity of partially adjusting the balance between the two classes of policies. A full consideration of these two important elements is therefore essential when dealing with any such scheme.

RESERVE VALUES.

In adopting the usual formula for the net value of a policy, namely, $A_{x+n} - \pi_x a_{x+n}$, we are at once confronted with a difficulty in dealing with this class. What pure premium should be introduced for valuation purposes and for the Board of Trade Returns? If the premiums receivable be fixed—say, £1. 16s. 4d. per-cent at age 30, and £2. 19s. 2d. per-cent at 45, as given on page 8, and the valuation be made at $H^1 3$ per-cent, then it is clearly incorrect to take credit for the net premiums of £1. 17s. 7d. per-cent and £3. 2s. 3d. per-cent respectively, seeing that they exceed the office premiums. If premiums somewhat smaller than those actually receivable be introduced, such as the office premiums less $2\frac{1}{2}$ per-cent—£1. 15s. 5d. and £2. 17s. 6d. respectively—and the sums assured be retained as £100, then the mere placing of two such policies upon the books would withdraw $\cdot 108 \times a_{30} = \text{£}2. 5s. \%$, and $\cdot 238 \times a_{45} = \text{£}3. 18s. 10d. \%$, from the reserves of existing policyholders. In widows' fund valuations a similar condition often holds, and the orthodox though conservative procedure in such cases is to discount the probable loss from new entrants and treat it as additional liability. The principal cause of the difficulty is that life offices prefer to value the whole of their business on one basis, and at a low rate of interest. In present circumstances the valuation of non-profit or discounted-bonus policies at

2½ per-cent cannot logically be defended, yet it is frequently done. If the pure premium inserted were in all cases less than the office premium payable, each policy under these sections would represent a considerable loss to the office; and a large new business at reduced rates might, if treated thus, prove disastrous to a life office: it would certainly be unfair to existing policyholders, whose surplus payments would be diverted towards making up the apparent loss incurred by the new entrants. Moreover, the policies themselves provide a means of guarding against loss, because, when the premium is a fixed quantity, the sum assured as a rule is liable to modification.

When the sum assured is variable the proper course would seem to be that, if any adjustment for valuation purposes be made, the sum assured should be operated upon, and not the fixed premium. On the other hand, if the sum assured be fixed, while the premium varies according to the rate of bonus declared, then it would probably be better to take credit for the full-profit premium and show the reductions on the other side of the account as "Reductions in anticipation of Bonuses." Little objection could be raised to the second plan, but the first is unsatisfactory. A reduction in the nominal sums assured for valuation purposes might be viewed by the public as a forecast of the future. Certainly rival agents would not neglect so strong an argument, and would point to the modification as a confession from headquarters of the inherent weakness of the scheme. Moreover, it would not be consistent that an office should issue a policy in which the sum assured is nominally stated at £100, while treating it as something less in estimating its liabilities.

While, therefore, it is scarcely practicable to modify the sums assured, it does seem as if the *premium* to be valued should be not greater, but appreciably smaller, than the office premium receivable. Where policyholders are led to expect that the rate of bonus will be maintained, it seems better to face any apparent loss in the initial stages of the policy, if it be desired to value this business at a lower rate of interest than that realized. If the office premiums have been calculated by select 4 per-cent tables; and if, as is likely, the reduced premiums exceed the corresponding pure premiums on this basis, the latter might be inserted and valued at any rate of interest (not greater than 4 per-cent), or by any mortality table which the office may think fit to assume. This appears to the writer as the true theoretical, and, at the same time, practical method of treating such policies at an investigation; and

much may be said in favour of the treatment of full-profit policies in the same way. The original loading is left intact, and the apparent reserve for future expenses and bonuses remains the same from valuation to valuation. It is difficult to convince a person, only slightly conversant with actuarial science, that a life office has strengthened its position by reducing the rate of interest when he sees from the Board of Trade Returns that the "reserve for future expenses, profits, and contingencies" has been considerably *reduced*. This anomalous condition would be avoided if on all occasions the net premium on which the office rates are based were inserted. It is not intended that rigid and unreasoning adherence to the *first* basis of the premiums would be adopted. Such a course would be an absurdity and might introduce Northampton 3 per-cent pure premiums. But if the office now bases its calculations of premiums on Select Tables with $3\frac{1}{2}$ per-cent or $3\frac{3}{4}$ per-cent interest, then the corresponding pure premiums might be adopted in estimating the value. A further argument in favour of this method is, that when the contribution plan of distribution is followed, a reduction in the rate of interest by the usual method completely alters the incidence of the bonuses, giving a much smaller proportion than before to recent entrants; but if the reduction in the rate of interest were applied only to the annuity and reversion, no such disturbance would take place.

Mr. G. F. Hardy indicated that for discounted-bonus policies the reserve value might reasonably be computed at a higher rate of interest than for full-profit policies. The argument for this position may be thus expressed:—"If an interest margin is "necessary for the maintenance of a uniform reversionary bonus, "then, seeing that the future bonuses have been discounted and "do not represent an increasing liability, the interest margin "ceases to be essential." The argument does not at first sight appear to cover all the circumstances. One would suppose that the policies ought to contribute the same profit annually to the general surplus as full-premium policies do. If the reserve be the same as for the sums assured only under full-profit policies, then the surplus from interest will be considerably smaller. If, therefore, the interest margin be more than sufficient to maintain the same rate of bonus for the future, the discounted-bonus policies do not contribute a fair proportion of the divisible surplus. But if the interest margin be so arranged as to

maintain the reversionary bonuses and no more, then the position as defined by Mr. Hardy is strictly accurate.

Several investigations have been made in order to arrive at the surplus interest which will maintain an assumed rate of bonus, but attention has seldom, if ever, been directed to the fact that, if the bonus additions be surrendered, the reserve held for the sum assured should be further strengthened in order that the surplus interest may equal that earned on the larger reserve when the bonuses remain attached. This is a matter of considerable importance in the case of offices declaring uniform reversionary bonuses and giving cash options which are freely taken; but compound-bonus offices are protected if the future declarations are based upon the net sum assured only.

The foregoing deductions are based upon general reasoning, and it is desirable to test such reasoning by means of a concrete example. The Retrospective Method of Valuation affords a convenient means of tracing the gradual accumulation of the reserves for any special class of business. In order to examine the effect of transacting business at reduced rates, and compare the reserves held at various epochs with the reserves for full-profit policies, the following schedules have been prepared. They show the progress of a fund formed by the effecting of £10,000 of assurance at the age of 30, and proceed on the assumption that select mortality with 4 per-cent interest are adopted in calculating the premiums, also that the same rates hold throughout the duration of the assurance. The full-profit rate is that for age 30 deduced by the formula previously given; and it is assumed that economical management, combined with profit from miscellaneous sources, enables the office to earn bonuses at 30s. per-cent per annum. In other words, it may apply $\left(\pi_{[x]} + \frac{\cdot 01}{a_{[x]}} + \frac{\cdot 015R_{[x]}}{N_{[x]}} - \cdot 01\right) = \cdot 014194$ per unit assured, during the first year, and $\left(\pi_{[x]} + \frac{\cdot 01}{a_{[x]}} + \frac{\cdot 015R_{[x]}}{N_{[x]}}\right) = \cdot 024194$, subsequently, towards meeting the net risk and providing bonuses.

The following shows the working of the full-profit schedule during the first few years:—

FULL PROFITS.

Premiums and Fund.

Year	Premium for year	Fund at beginning of year	Interest at 4 per-cent	(3)+(4)	Claims	Balance (5)-(6) Fund at end of year
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	141.9	141.9	5.7	147.6	45.7	101.9
2	240.9	342.8	13.7	356.5	73.1	283.4
3	239.1	522.5	20.9	543.4	88.6	454.8
4	237.1	691.9	27.7	719.6	95.8	623.8
5	234.9	858.7	34.3	893.0	98.5	794.5
&c.	&c.	&c.	&c.	&c.	&c.	&c.

Sums Assured and Bonuses.

Year	Sums Assured	Bonuses	CLAIMS	
			Sums Assured	Bonuses
	(8)	(9)	(10)	(11)
1	10,000	150.0	45.0	.7
2	9,955.0	298.6	71.0	2.1
3	9,884.0	444.8	84.8	3.8
4	9,799.2	588.0	90.4	5.4
5	9,708.8	728.3	91.6	6.9
&c.	&c.	&c.	&c.	&c.

The same results might have been arrived at by direct calculation at the various points; but the formulas would be complicated and troublesome in application, and it was better to trace the fund in the manner shown, as effective checks by summation were available. In the case of discounted-bonus policies, however, no such schedule is required, because the sums assured are exactly the same as are given in that for full-profit assurances, while the retrospective formula for computing the accumulated fund is not complicated by bonuses.

For the discounted-bonus policies it is assumed that 30s. per-cent is anticipated, and the value at 4 per-cent deducted, so that such assurances become non-profit for all practical purposes, if the assumptions hold. The effective premiums are $\left(\pi_{[x]} + \frac{\cdot 01}{a_{[x]}} - \cdot 01\right) = \cdot 007701$, for the first year, and $\left(\pi_{[x]} + \frac{\cdot 01}{a_{[x]}}\right) = \cdot 017701$, subsequently. The accumulated fund at the several stages was therefore obtained by means of the following:—

$$S_{x+n} \times \left\{ \frac{.017701(\mathbb{N}_{[x]} - \mathbb{N}_{x+n}) - (M_{[x]} - M_{x+n}) - .01D_{[x]}}{D_{x+n}} \right\},$$

in which S_{x+n} represents the sums assured remaining in force at age $x+n$.

It is not necessary to reproduce the calculations here in full. They give information on various points of practical interest; but the only figures of value for the present purpose are given in columns (2) and (5) of the undernoted schedule. The ordinary reserve values by the H^M Table at various rates of interest are shown alongside.

Comparison of Fund arising from the accumulation of Premiums, with the corresponding Reserve-Values.

Year	FULL-PROFIT POLICIES			DISCOUNTED-BONUS POLICIES		
	Amount of Fund	Ordinary Reserve Value		Amount of Fund	Ordinary Reserve Value	
		H^M 3 per-cent	H^M 3½ per-cent		H^M 3½ per-cent	H^M 4 per-cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)
5	795	900	815	453	540	495
10	1,644	1,820	1,664	949	1,086	1,004
20	3,406	3,643	3,398	1,983	2,152	2,025
30	4,647	4,886	4,649	2,667	2,825	2,705
40	4,349	4,502	4,355	2,427	2,519	2,448
50	2,055	2,099	2,057	1,100	1,123	1,103
60	257	258	255	137	131	129

Similar Schedule reduced to the Basis of £100 of Assurance remaining in force, with relative Bonuses attached in the case of Full Profits.

Year	FULL-PROFIT POLICIES			DISCOUNTED-BONUS POLICIES		
	Amount of Fund	Ordinary Reserve Value		Amount of Fund	Ordinary Reserve Value	
		H^M 3 per-cent	H^M 3½ per-cent		H^M 3½ per-cent	H^M 4 per-cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)
5	8.1	9.4	8.5	4.7	5.6	5.2
10	18.0	19.9	18.2	10.4	11.9	11.0
20	42.6	45.5	42.5	24.8	26.9	25.3
30	72.7	76.4	72.7	41.7	44.2	42.3
40	106.2	109.9	106.4	59.3	61.5	59.8
50	138.9	141.9	139.1	74.4	75.9	74.6
60	169.1	169.8	167.7	90.1	86.0	85.1

It will be observed that a valuation by H^M 3½ per-cent follows the course of the full-profit fund with remarkable consistency,

thus again confirming the investigations made by others, and showing that, when bonus additions remain attached to the policies, and the other assumptions hold, a margin of $\frac{1}{2}$ per-cent will just suffice to maintain a 30s. simple bonus.* If the full-profit policies be valued at $3\frac{1}{2}$ per-cent, and discounted-bonus policies at 4 per-cent, the full-profit fund after five years is £20 less than the reserve, while the discounted-bonus fund is smaller than the reserve by more than double that sum—£42. Accordingly, the fund arising from the accumulation of the discounted-bonus premiums is shown to be much less capable of sustaining the initial deduction for commission than a similar fund from full-profit premiums. This arises from the fact that the bonus added in the early years has a smaller value at the date of declaration than the bonus loadings paid, or than the bonuses anticipated.

The method adopted affords an easy means of modifying the assumptions as to initial expenditure and as to the rate of interest employed for discounting bonuses. Thus, if the initial expenditure were 30s. per-cent instead of 20s. (the renewal expenditure and effective premiums, after the first, remaining the same), then the accumulated fund would be as shown in column (3) below. On the other hand, if the deductions from the full-profit premiums were made at $4\frac{1}{2}$ per-cent instead of 4 per-cent, the results would be as in column (4); while, if both these modifications were made, the result would be as shown in column (5).

DISCOUNTED-BONUS POLICIES.

Year	FUND ACCUMULATED FROM PREMIUMS				Reserve Value 4 per- cent ex. 1st Year
	As given on page 28	When Initial Expenditure is 30s. per- cent	When Bonus is discounted at $4\frac{1}{2}$ per-cent Interest	(3) and (4) combined	
(1)	(2)	(3)	(4)	(5)	(6)
5	453	392	488	427	406
10	949	875	1,023	950	924
20	1,983	1,873	2,171	2,051	1,966
30	2,667	2,505	2,988	2,826	2,669
&c.	&c.	&c.	&c.	&c.	&c.

* It must be remembered that in this investigation the premiums are supposed to be paid on the exact day they fall due, without the usual month of grace, and, further, that they are invested immediately to yield the full rate of interest. As these conditions do not hold in practice, a careful actuary would preserve a larger margin than $\frac{1}{2}$ per-cent between the rate realized and the valuation rate.

This table is of value for the first few years only. Any loss arising from large initial expense would not in practice be accumulated at interest and mortality during the currency of the policy, as is assumed in the continuing values of column (3), but would presumably be cleared off at the first investigation. Similarly, any benefit arising from the adoption of $4\frac{1}{2}$ per-cent interest in the anticipation of bonuses would not be accumulated with benefit of survivorship, but would be distributed at each investigation. This benefit would exist in a decreasing series from first to last. The extent of it for the five years preceding various points is shown in the following statement :—

Benefit arising during quinquennium ending with the n th year from adopting $4\frac{1}{2}$ per-cent in discounting bonuses of 30s. per-cent, when 4 per-cent is realized.

Year n	From Sums Assured remaining out of £10,000 effected at Age 30	For each £100 of Assurance in force
5	34.5	.36
10	32.9	.36
20	29.3	.37
30	24.2	.38
40	17.0	.42
50	7.8	.53
60	1.3	.87

Comment regarding these figures is scarcely necessary. They indicate that a considerable sum might have to be taken from the general surplus in order to make satisfactory reserves for discounted-bonus policies, and that the transacting of a large new business at the reduced rates might force an office to adopt a less strict basis of valuation. Thus, on the combined assumptions of 30s. per-cent of initial expenditure, and bonuses discounted at $4\frac{1}{2}$ per-cent, an office would have to draw upon its existing policyholders to the extent of £540—£427, or £113, for each £10,000 of business placed at age 30, in order to value the balance of such business five years later by H^M $3\frac{1}{2}$ per-cent. The amount withdrawn in event of the valuation being made at an earlier stage, *i.e.*, after the business had been in force for only two or three years, would be even greater; while, of course, a 3 per-cent valuation would call for still larger deductions from the general surplus. If the H^M and $H^{M(5)}$ Tables were employed, a further sum would be withdrawn at the second

investigation ; but thereafter the policies would contribute to the surplus, and would help to bear the burden laid upon the office by the introduction of new and expensive policyholders. One means of avoiding the heavy withdrawal from the general surplus at the first investigation would be to value such policies at a higher rate of interest than that adopted for the full-profit business, and at the same time throw off the first year. The reserves on this basis are shown in column (6) above, but any such method would not commend itself to British actuaries generally. It is like shirking a responsibility.

This question is of much importance, because the recent development of this business has been remarkable. Detailed particulars of the new assurances effected are seldom available, but in some cases the volume of discounted-bonus business nearly equals that at full rates. What would be the result if the full-profit business were to disappear entirely? Can it be supposed that any office out of premiums, less than the pure $3\frac{1}{2}$ per-cent select rates, could maintain a sufficient reserve to meet the sums assured as they fell in? If such a reserve were kept, it would surely be out of the accumulations left by past policyholders. The system is admittedly dependent upon the full-profit class ; it does not possess inherent strength enough to stand alone, but leans for support against the solid system of full rates.

SURRENDER-VALUES.

The surrender-value of a policy must to a certain extent be dependent upon the reserve-value, but the latter should not form the final basis on which surrenders, especially of discounted-bonus policies, should be calculated. A short consideration of the foregoing tables clearly proves this. If a life office, from prudential motives, arbitrarily increases the fund which has accumulated from premiums received, reserves a larger sum, and writes off an apparent loss at the first investigation, surely the assured should not benefit from the adoption of this conservative course. The balance has had to be taken from the surplus which would otherwise have gone to full-profit policyholders, and *they* are entitled to be recouped should a discounted-bonus policy be surrendered. The same argument holds in the case of full-profit policies in the early years, and it conclusively proves that the payment of any fixed proportion of the reserve-value must be unjust when made indiscriminately to policyholders of short

or of long duration. Several offices bear practical testimony on this point, and calculate surrender-values at an investment rate of interest. The excluding of the first year from the calculation, in order to make some allowance for initial outlay, is a further precaution sometimes taken, and is one likely to be adopted more freely in the future. The point is of greatest importance in the early years of the assurance, as is shown by the foregoing accumulation schedules; and after a policy has endured for 15 or 20 years the reserve-value might fairly be taken as the basis for surrenders.

Much may be said in favour of the retrospective method being applied to the calculation of surrender-values in the early years. It admits of a good defence theoretically, facilitates the making of a proper allowance for initial expenses, and returns to the policyholder his effective contributions accumulated at the rate of interest assumed by the office. The formulas may not, however, be so simply applied as those of the prospective method, and this would prove a serious objection, especially when it is borne in mind that the latter method may be adjusted so as to give somewhat similar results. One great merit of the prospective method and the use of net values is that the system applies throughout the entire duration of the policy. If the retrospective method and office premiums less actual expenses, be employed, then a slight modification in the interest basis completely alters the accumulated amount when many years have elapsed, but this objection is of little importance in the early years. As this essay is not meant to discuss the general question of surrender-values, but only the treatment of a special class as compared with ordinary policies, it will be better to assume a rule which may be readily applied and will give useful comparative values.

One of the simplest practical rules for the computation of surrender-values is that under which the H^M 4 per-cent value excluding the first year is allowed. This rule is followed by at least one office; but it probably brings out higher surrender-values than would be adopted by most actuaries. Ninety per-cent of this value would approximate better to the practice of some of the more liberal offices. The following tables show how such rules work when applied to full-profit and discounted-bonus policies.

FULL-PROFIT POLICIES.—*Assurance of £100 with Reversionary Bonus Additions of 30s. for each year.*

Years elapsed	Accumulated Fund (see page 28)	HM 4 per-cent Value ex. 1st Year	90 per-cent of (3)	(2)–(3)	(2)–(4)
(1)	(2)	(3)	(4)	(5)	(6)
5	8·1	6·8	6·1	1·3	2·0
10	18·0	15·8	14·2	2·2	3·8
20	42·6	39·0	35·1	3·6	7·5
30	72·7	68·7	61·8	4·0	10·9

DISCOUNTED-BONUS POLICIES.—*Assurance of £100.*

Years elapsed	Accumulated Fund (see page 28)	HM 4 per-cent Value ex. 1st Year	90 per-cent of (3)	(2)–(3)	(2)–(4)
(1)	(2)	(3)	(4)	(5)	(6)
5	4·7	4·2	3·8	·5	·9
10	10·4	10·1	9·1	·3	1·3
20	24·8	24·6	22·1	·2	2·7
30	41·7	41·7	37·5	0	4·2

These tables call attention to several most important points. Columns (5) and (6) may be looked upon as the contributions made towards future expenses by policyholders who surrender, and the varying influence of the two classes of policy is apparent when the same rule is applied to each. The difference between the accumulated fund and the pure value excluding the first year, increases with the duration of a policy with full profits, but decreases in the case of a discounted-bonus policy. Indeed, column (6) of the latter table roughly approximates to column (5) of the former. Further, the deduction of 10 per-cent has a greater effect when made from the larger fund held for policies with profits. Even the excluding of the first year appears to affect the discounted-bonus policy in a minor degree, but the reason for this was shown when discussing the subject of reserve-values. If it be thought right to estimate surrender-values of full-profit policies at 4 per-cent when the reserve is probably calculated at 3 per-cent, then, seeing that the reserve for discounted-bonus policies might be estimated at a higher rate, whether it be so in practice or not, probably it is right to calculate the surrender-values at a higher rate also. The

following table shows how the relative figures work out when $4\frac{1}{2}$ per-cent interest is used.

DISCOUNTED-BONUS POLICIES.—*Assurance of £100.*

Years elapsed	Accumulated Fund (see page 28)	H^M $4\frac{1}{2}$ per-cent Value ex. 1st Year	90 per-cent of (3)	(2) - (3)	(2) - (4)
(1)	(2)	(3)	(4)	(5)	(6)
5	4.7	3.9	3.5	.8	1.2
10	10.4	9.4	8.5	1.0	1.9
20	24.8	23.2	20.9	1.6	3.9
30	41.7	40.0	36.0	1.7	5.7

It is evident from what precedes that surrender-values of discounted-bonus policies can scarcely be on the same liberal scale as may be allowed in the case of full-profit policies; and, if the value paid on the surrender of a policy in the latter class be calculated as 90 per-cent of the pure H^M $4\frac{1}{2}$ per-cent value, excluding the first year, then it is probably not too much to say that for discounted-bonus policies the corresponding amount should be something like 80 per-cent of the pure $4\frac{1}{2}$ per-cent value. This may appear stringent, but the conditions of the case seem to call for the same contribution towards surplus, and towards future expenses, from the one class as from the other. Mr. G. F. Hardy called attention to the fact that offices seldom take intermediate bonuses into account when estimating surrender-values, and that some adjustment is necessary on this score. Another element in the case is that the bonuses added in the early years have a smaller cash value than the equal annual equivalent; and, as no account is taken of the difference between the present values of future bonuses and of future bonus contributions in estimating surrender-values, it follows that discounted-bonus policies would derive an advantage from this source on surrender, because in effect the difference between such values is allowed for. Of course it follows that the same minimum percentage of the premiums paid cannot be guaranteed to discounted-bonus as to full-profit policies. This, however, is self-evident from the fact that the risk run is practically the same, while the premiums received differ so greatly, and the surrender-value must be paid from the excess of the premiums over the risk.

Paid-up Policies. Paid-up policies are analogous to surrender-values, but they may more fairly be made to depend upon the reserve, because no withdrawal of cash takes place, but the funds remain intact. If, however, the whole, or nearly the whole, of the reserve-value were allowed in estimating the paid-up assurance, then the new sum assured should be subject to the same conditions as the old in regard to increase or diminution, if future bonuses exceed or fall short of the anticipated amount. In such circumstances there would seem to be no objection to the use of the well-known formula for a paid-up policy $\cdot 9 \left(1 - \frac{P_x}{P_{x+n}} \right)$. On the other hand, some offices make all their paid-up policies non-participating, and in that case presumably the reduced sum assured would be guaranteed. The method of calculation would then be on exactly the same lines as those laid down for surrender-values, except that a smaller percentage deduction would be made.

DEFICIENT BONUSES.

In thinking out actuarial problems, the writer has found the practice of carrying any conclusion to its extreme limit a most useful one. Should there be a lurking fallacy, this method frequently results in a *reductio ad absurdum*, and necessitates a careful analysis of each step of the reasoning. In considering the question of deficiency in bonuses, this course leads to the contemplation of two positions which discounted-bonus policyholders might occupy:—*Firstly*, that of bonuses disappearing entirely—a case already discussed (*J.I.A.*, xxxi, 270, 275, &c.) ; and, *secondly*, that of negative bonuses, *i.e.*, the office being insolvent. Confining attention to the case of the premium being fixed and the sum assured variable, the position of discounted-bonus policyholders, on the winding-up of a company, might be viewed in four very different ways. Which of them might actually be adopted as the strict legal method, I leave competent authorities to say. In equity, the second position is probably the fairest.

- (1) The rule for valuing a policy as fixed by the Life Assurance Companies Act, 1872, might be applied in its literal sense, and the sum assured (increased or decreased by previously declared bonuses) valued by the Seventeen Offices' Tables at 4 per-cent. The

result then brought out would be the sum for which the policyholder would rank in a distribution of assets.

- (2) Seeing that, if the bonuses disappear entirely, the sum assured becomes periodically diminished, then the policyholder's claim in event of insolvency might be determined as if the policy were a decreasing assurance without profits, at a level rate of premium.
- (3) The holder might be treated on all fours with the full-profit policyholders of the company, seeing that he is equally interested in the profits. The sum assured would be reduced in that proportion which the premium payable might bear to the full-profit premium, and the policy would thereafter rank in the distribution of assets as of such reduced amount.
- (4) It is possible to imagine that a fourth and still more rigid view might be taken, and that, as there is no guarantee of the sum assured, there is consequently no liability on the part of the office on insolvency. In other words, that the reserve of discounted-bonus policies would be entirely swept away in event of the office being unable to meet its guaranteed contracts for sums assured, under full-profit and non-profit policies.

It is probably unnecessary to enter into any lengthy discussion of the merits and demerits of each of the four methods, as these will at once occur to any actuary. The first is based on the rule so frequently adopted in bankruptcy proceedings, that the claim should be estimated according to the liability on the day before the winding-up order. The second and third depend more upon the equitable treatment of the various classes of policyholders, while the fourth is suggested by the fact that there is nothing guaranteed in the contract. The first method would certainly give to discounted-bonus policies an undue preference, not only over with-profit policies, but even over those in the non-profit class; while, on the other hand, the fourth method would have the same effect as if the discounted-bonus policyholders were guaranteeing the sums assured of the other two classes. Indeed, the fourth method would treat the three classes of policyholders—non-profit, full-profit, and discounted-bonus—in much the same way as the three common classes of shareholders—preferred,

ordinary, and deferred—would be treated if it were stipulated that the first two should rank equally on a distribution of assets.

We may congratulate ourselves that this question of insolvency is not likely to arise in any practical form. The discussion of the theory has, however, the merit of still more forcibly impressing several facts:—

- (1) That a policy of this nature lacks stability;
- (2) That there might be difficulty in determining the legal rights of parties; and
- (3) That it is desirable to have definite contracts, and that the relative positions of the two classes of participating policyholders should be very clearly defined, all the contingencies which might possibly arise being kept in view.

CONCLUSION.

This system contains one of the features of assessmentism; certainly not one of the most objectionable features, but one which is nevertheless undesirable, namely, the substitution of a policy under which the sum assured is liable to reduction, or the premium to increase, in place of the familiar guaranteed contract at a fixed premium. What actuary in this country would be bold enough to found an office to transact business solely at the discounted-bonus rates sometimes adopted? A similar scheme is known in America as the flexible-premium plan, which occupies an intermediate position between assessment and old-line companies. The right to make an assessment is retained should a deficiency in the reserves occur, and the lapse element is introduced in calculating the premium rates, on the understanding that no surrender-values will be paid. Very low premiums—sometimes even lower than the discounted-bonus rates here—are generally quoted. It is sufficient to say that the experience of policyholders in such companies has in many cases been far from agreeable.

From each succeeding point from which the question at issue may be viewed, except perhaps the desire on the part of insurers to get the largest immediate protection at the very lowest cost, the objections to the extreme form of discounted-bonus policies become more and more apparent. The questions of (1) Equity between different policyholders, (2) Likelihood of bonus rates

being maintained, (3) Reserve-values, (4) Surrender-values, and (5) Insolvency, all converge in the one direction, and pronounce a general verdict against the issue of policies where the sum assured and premium may not be definitely ascertained at any time. If the discounted-bonus system were followed in the modified form suggested on page 21 as a mean between full-profit and non-profit rates, then it could be applied equitably and easily to endowment assurances, limited payments, and other classes. One class of policyholders would take the risk of the bonuses falling below a certain rate, but they would receive remuneration for the risk, so that the spirit of equity would be preserved between the different sections, while each of them would be self-supporting.

DISCUSSION.

MR. W. HUTTON considered that Mr. Moir had very fairly set out the arguments for and against the discounted-bonus system. The great argument in its favour appeared to him to be the very natural desire on the part of the public for the policy which shall be subject to a low rate of premium and yet which shall not involve too great an ultimate sacrifice for the sake of mere cheapness at the outset. The author had detailed a number of practical disadvantages underlying the scheme, but it was hardly fair to condemn it in respect of some of those for which it was not exclusively responsible. The argument, for example, that the system gave an opportunity to the proposer to exercise selection against the office by choosing cheaper tables applied already in the choice the proposer had among the various systems of insurance. Pushed to its extremity it would seem to point to an office doing only one class of contract. Again, the argument that no office could now be started with hope of success to do that class of business at current rates had some force also when applied to full-profit policies if the present rates of bonus were to be maintained; and the loss of profit from lapses was felt under full-premium policies since it had become increasingly the practice to guarantee minimum surrender-values from the outset. It was, perhaps, a strong argument in favour of the practicability of the system that it had been in operation in one office for nearly fifty years with very satisfactory results. But while that was so, he agreed with the author that there was an objection to combining in one office two opposite systems of distribution of surplus, where the two classes were not kept distinct. Under the discounted-bonus policies a uniform cash rebate was allowed from the premium payable, in exchange for an annual reversionary benefit, the cash value of which increased with the duration of the policy. It was evident, therefore, that relatively to the full-profit policies, the discounted-bonus policies received too much in the early years, and thereby the incidence of the surplus was disturbed. Further, that disturbance was liable to

be accentuated by any rapid increase or diminution of the business in either of the classes. But the great argument against the adoption of the system seemed to be that it tended to interfere with the development of the office and with its freedom of action. It appeared to him that an office adopting the system was really taking on its back an Old Man of the Sea, who would more and more interfere with its freedom of action the longer he was allowed to remain there. Theoretically, the system implied the reduction of the sum assured should bonuses fall below the discounted rate, but that was a necessity from which every actuary would shrink. The face-value of a policy had been always regarded as inviolate, and the whole traditions of British life assurance would be revolted by any tampering with the sacred thing. The result would be a tendency for the other interests of the office to be subordinated to the maintenance of the discounted bonus rate. It was easy to see at how many points that would interfere with freedom of action. It might, for example, be considered desirable to extend the business, and with that end in view to incur a certain amount of special expenditure. Again, it might happen that the time would come when, in the permanent interest of the office, the question of the reduction of the bonuses ought to be faced. On the other hand, a larger distribution of surplus might be considered desirable in equity to existing policyholders. In any one of these proposals the influence of such a system as that under consideration would make itself powerfully felt, and would interfere unduly with the ultimate policy adopted by the office. While, therefore, he considered that the system did satisfactorily meet a public demand, and was capable theoretically of a perfect defence, he agreed with the author that any system that did not guarantee the face-value of the policy was to be condemned.

MR. J. SORLEY said that with the general conclusions of the paper he was disposed to agree, but, as he would point out later, there were a small minority of offices which might with safety adopt discounted bonus rates producing premiums less than the normal non-participating ones. He was interested in Mr. Moir's conclusion that the expenses of an average office had, during the last twenty or thirty years, increased $2\frac{1}{2}$ per-cent, equivalent to a diminution in simple bonus rate of about 3s. per-cent, while the improvement in mortality during a similar period was equivalent to an increase of a like amount of bonus; the two alterations thus in effect neutralizing each other. Mr. Moir was probably wrong in pointing to the reduction in the amount of extra premiums for foreign travel and residence charged as indicating a further diminution of profit-earning power, for the risk under this head had greatly diminished in modern times, as was indeed proved by the diminution in the rate of mortality in spite of the greater liberty now allowed to insurers at normal rates. The author indicated that revised premium calculations should be made at $3\frac{3}{4}$ instead of 4 per-cent; but he thought that most of them would agree that a rate not higher than $3\frac{1}{2}$ per-cent should now be used. For single-payment policies, without profit, rates should not be less than the 3 per-cent pure rates, although various offices which made a 3 per-cent reserve still offered to issue policies at less than a 3 per-cent pure rate. The statement that "premium rates should

be so consistent one with another that it becomes immaterial to an office which table or scheme was selected by a proposer—they should all be remunerative in an equal degree,” was too sweeping. Participating policies should contribute equitably to the bonus fund, but there was no principle requiring that similar margins of profit should be insisted upon in all classes of without-profit policies. They must be content with such varying profits as market rates allowed—always provided that in each case a reasonable margin should be obtained. It was also probably wrong to defend a discounted bonus system producing a rate slightly higher than non-profit rates, as affording, if the worst came to the worst, a larger margin of profit than the latter, for before the bonuses on such policies entirely vanished, considerable additions would doubtless have been made to the sums assured, and the rate of premium on the increased amount at risk thus rendered really less than the non-profit rate. With reference to a $2\frac{1}{2}$ per-cent valuation, he was not prepared to admit that, with present market rates, the difficulties presented by such a valuation were exclusively an incident of discounted-bonus schemes. Take, for example, the case of single-payment policies without profits, to which he had formerly alluded. In their valuation government returns it was not absolutely necessary to set out the value of the pure premiums, and if they inserted a $2\frac{1}{2}$ per-cent reserve for discounted-bonus policies, they obviously made a more ample provision for such policies than they would do if they assumed $3\frac{1}{2}$ or 4 per-cent interest so as to show some loading on the pure premiums. Passing from such incidental points of criticism, he would state his general conclusion that as a matter of practical wisdom—theoretical demonstrations notwithstanding—no office should adopt a discounted-bonus system if it had also to adopt a system of valuation under which the reserves for such policies were reduced. People would argue that if the reserves for the ordinary policies were just sufficient, then those for the discounted-bonus policies were inadequate. There were a limited number of offices that had large surplus funds accumulated from previous generations of policyholders who had passed away, and which it would be injudicious to distribute at once. Such offices might fairly adopt a table of discounted bonuses, but from the conditions of the problem they would obviously desire to make the fullest reserves for such policies, and in this form conserve a portion of their surplus for the future, and they would certainly not seek to plead a theoretical demonstration that discounted-bonus policies required diminished reserves.

Mr. GEO. KING thought that there were really only two classes of policies with discounted bonuses. At first sight it might appear there were three—namely, where the bonus system of the office was a compound reversion, where the system was a simple reversion, and where the system might be called cash bonuses. The first two, however, it seemed to him were really identical, because it was part of the system of discounted bonuses that the bonuses declared at each valuation disappeared, having been as it were surrendered against the reduction of premium, and therefore they no longer remained to carry bonuses on themselves. He did not see, therefore, how they could fairly treat compound bonuses by discounting a

compound bonus; in every case he thought a simple bonus only ought to be discounted. In saying that, he knew there were weighty authorities against him, but, nevertheless, after careful thought, he still stood by his opinion. The question was, therefore, limited, with slight differences according to the peculiarities of different offices, to two broad classes of discounted bonuses—the uniform reversionary bonus system and the cash bonus system. He did not agree with the author when he said that the uniform reversionary bonus system might be said to occupy a position about midway between the cash and the compound reversionary bonus system. It seemed to him that the two systems differed very materially in principle. In the case of the cash bonus system, an office merely advanced at an agreed rate of interest a certain proportion of the premiums as a charge against the policy, and the full premium must necessarily appear in the revenue account; while the reduction of premium did not appear in the revenue account at all, but went into the balance sheet as an investment in policy loans. At each quinquennium the matter was cleared off by writing off the loan against the cash bonus; or, if the cash bonus was not sufficient, by adjusting the transaction in some other way, and the arrangement was started afresh. Therefore, in the case of the cash bonus there was no difficulty whatever—they were merely ordinary policies on which money was lent. He agreed that at the outset some little adjustment might have to be made, because practically the system gave a surrender-value from the beginning, and most offices allowed two or three years to elapse before granting a surrender-value, but that was a very small detail. Looking now at the discounted uniform reversionary bonus, it seemed to him that that also was quite easy, and that it was made to appear most unnecessarily complicated in the analysis given by Mr. Moir. What was it? There was simply an ordinary policy with another contract superimposed upon it, the contract being that the office sold an annuity to the policyholder, the purchase price of which was an increasing reversion. Whether that increasing reversion was to be discharged by the bonus, and failing the bonus, by the sum assured, or whether there was to be an adjustment of the premium later on in the event of insufficiency of bonus, it did not matter. There was a pure and simple contract at the beginning—the sale of an annuity by the office in consideration of a reversion which the policyholder secured upon the policy. Looked at from that point of view, it seemed to him that the difficulty really disappeared. It seemed to him that the full premium should appear in the revenue account, and, therefore, the difficulty about a reduced premium income showing a larger percentage of expenses, even although the actual expenses were reduced, did not exist. On the other side of the revenue account there would be an entry for the abatement of the premium. That seemed to him the proper way of dealing with the transaction. Similarly, when they came to the valuation, the policies were valued purely and simply like an ordinary policy, and then the superimposed contract was valued independently. They valued as an asset of the office the future bonuses to be received, the future increasing reversion; and they valued as a liability the future

reductions in premium. The past had taken care of itself by the past bonuses having been wiped off against the reduction. The effect of that method of valuation, which seemed to him to bring to light the true meaning of the transaction, was that a reduction of liability was obtained under these policies as compared with ordinary policies, and he thought properly so. The future increasing reversion would always be of greater value than the future reductions of premium, and therefore the office had an asset in that particular matter, but the amount was usually very trivial. He had tested it in a great many ways, and it was always a small amount. Prosperous companies with large funds might ignore it, and simply value the policies like ordinary policies, but if they liked they would be quite justified in bringing into account the adjustment, as a small asset arising from the system of discounted bonus. Coming to the surrender-values, the same principles exactly applied. The policy was valued like an ordinary policy in the usual way, and the asset he had already mentioned was deducted from it. At the beginning the value of the asset was small, but it reached a maximum at a certain stage, dependent upon the age at entry, the duration of the policy, and the table of mortality employed, and then it gradually tailed off again until, at the oldest age in the table, it disappeared altogether. Going to the end of the paper, it seemed to him that the author had omitted from the four methods of dealing with the policies in liquidation the very one that set forth the contract in its proper form. There again the policy would be an ordinary policy, like any of the others, and it would have super-imposed upon it the contract, the sale of an annuity, in consideration of an increasing reversion. That made the whole thing simple, and it seemed to him, therefore, that although it was extremely interesting, a large part of the latter portion of Mr. Moir's paper was a little beside the mark. Dealing now with the question not from the actuarial side, but from the management side, he had had some experience in that direction, and he had not found that the non-profit business of an office was in any way interfered with, although the discounted-bonus table of premiums might show lower rates than the non-profit. Non-profit policies usually related to financial transactions and business of that kind, and it was almost unknown for a person to go in and insure non-profit simply for provident purposes. Discounted-bonus policies, with the little uncertainty which existed as to the future premium or as to the future sum assured, did not suit that class of business, and therefore it was not found that the non-profit business was, at least appreciably, interfered with. He quite agreed that great caution must be exercised in the estimation of the bonus to be discounted. It would be a great mistake to go too far, because it would be inconvenient—although possibly not more than inconvenient—if they were obliged to declare a bonus smaller than that discounted. Then he thought in one sense it was an advantage to have the discounted-bonus system because it imposed care on the management of the office. They must not go in for reckless expenditure and extension, which he thought was one of the evils of the day. There was, however, a danger which should be most strongly fought against, and that was that if the valuation disclosed

rather meagre funds, and if in the ordinary circumstances one would feel compelled to lower the bonus, there was the temptation to declare more than perhaps was wise, so that the bonus should not fall below that discounted. That, he thought, the actuary should set his face against, and at once meet the reduction of bonus rather than allow the difficulty to accumulate to a future period. With regard to the questions of discounted-bonus tables showing a lower rate of premium than the non-profit, and Mr. Moir's remarks deprecating the system because they should try to make their tables such that it was a matter of indifference to the company which table the proposer selected, from the very nature of the case he did not see how that was possible. In another part of his paper the author said, and with reason, that in the long run a with-profit policy was more profitable to the policyholder than one non-profit, and that the public had come to understand that. Those policies being only ordinary with-profit policies with a certain arrangement super-imposed upon them, they necessarily were more profitable in the long run to the policyholder than the non-profit policies, and that came out in the low rate of premiums which they disclosed. That was not a thing which could be avoided. It arose from the very nature of the case.

Mr. MANLY asked at what rate of interest Mr. King calculated the super-imposed contract?

Mr. KING said it could be done either at the valuation rate or at the rate at which the bonuses were originally discounted; it was a matter of convenience, and did not make much difference, the item being small.

Mr. H. E. W. LUTT thought that the consideration of the advantages and disadvantages of the discounted-bonus system was not now of such great importance as the question of dealing with the existing policies; and that must be taken into account, as the system had apparently come to stay. As regarded the actual contract itself, they had under the with-profit policy certain bonuses which they were assuming would be allotted to the policy at the end of each quinquennium, and whether simple or compound, the bonuses would be given. If they permitted the bonuses to be discounted by a certain table of mortality and at a sufficiently remunerative rate of interest, surely in that discounting allowance must be made for either a simple or a compound reversionary bonus as the case might be, and a policyholder who would receive a compound reversionary bonus would be entitled to the higher amount, and would look for a larger reduction in view of that payment. If one viewed the two sides of the question, the with-profit policy and the discounted-bonus policy, it seemed that, in making a comparison of the reserves, there was, under the super-imposed contract which Mr. King had explained, a diminution of liability, just as in the discounted cash bonus system there was the value of the policy on one side of the account and the loan on the policy on the other. They had their contract, which, a few years after the policy had been issued, could be taken credit for by the company, since they had already given to the assured by way of reduction of premium more than the value of the bonuses declared; and therefore he had less to receive in future if he kept

his policy in force. If he did not, that amount would be deducted from the surrender-value. He did not say that an office would always be entitled to diminish its reserves by a specific amount under any circumstances, but surely in considering the surrender-value, that deduction must be made, and therefore such surrender-value, if it related to the reserve in any manner, would indicate that the reserve need not necessarily be so much for a discounted-bonus policy, provided the office were prepared rigorously to enforce the conditions of its contracts in the possible result of a deficient bonus.

Mr. H. W. MANLY was pleased not only with the manner in which the author had treated the subject, but the style of the paper. It was written in simple and plain language with the ideas well arranged and the thoughts clearly expressed. One unfortunate word was used in the last paragraph but one in the paper, which he had no doubt Mr. Moir would see reason to alter—"insurer." He suggested it would be better if instead of using that word or any other which referred to the general public who wished to insure that "a section of the public" would be a better description of the class intended. There was also another point which he thought would make the author's argument a little stronger. On page 14 he made the statement that the average rate of interest earned by the insurance companies had fallen $\frac{1}{2}$ per-cent in 30 years. As a matter of fact it was considerably more than $\frac{1}{2}$ per-cent in twenty years. The fall in the actual rate had been much more rapid than that, and those who had the management of offices knew pretty well the reason why the fall did not show itself in the accounts. Coming to the subject of the general question, he was about to commit the same offence to some people that he did a year ago, and to say that no amount of jugglery could alter the fact that under the system they were discussing they undertook to insure a practically fixed sum at a very small rate of premium. Of course there were the conditions that the sum assured might be increased or diminished or the premium increased or diminished as the case might be according to the terms of the policy, but anything in the way of diminution of the sum assured or increase of the premium would certainly be considered by the assured as a failure on the part of the office to carry out the contract and amounting to almost a crime. He was afraid it was true that these conditions were not always explained by the agents of the companies. There was no possibility, according to the agents, of the sum assured ever decreasing, but, on the other hand, it was very likely to largely increase. There remained the fact, as brought out in Mr. Moir's paper, that some companies were offering to insure at net H^M select $3\frac{1}{2}$ per-cent premiums. Could they do it? It might be said that they were doing it and had been doing it. True they had been doing it when the average rate of interest had been £4. 6s., £4. 1s., £3. 19s., and £3. 18s. per-cent. But to whom did most of this interest belong? The rate of interest was very largely kept up by keeping the price of the securities down in the books, but the profit upon those securities really belonged to the old policyholders. Was it right then to use the interest obtained from them to keep up a branch of the business which could not possibly support itself? Could a new company be started and the

money received from those premiums be invested at the present moment to produce $3\frac{1}{2}$ per-cent and expenses, because expenses had to come out of the interest as no other provision was made for them? If that could not be done, then he came to the conclusion that the business was being done at a loss. That loss was small at present, but it was coming out of the funds which really belonged to the old policyholders. He might have misunderstood Mr. Sorley, but if they attempted to value these policies at the valuation at a lower rate than $3\frac{1}{2}$ per-cent, say at $2\frac{1}{2}$ per-cent, then they were making a reserve larger than they possibly could have in hand from those premiums. Where was that extra reserve to come from? It could only come from that reserve fund which had been created by the past policyholders, which could not go on for ever.

Mr. SORLEY said that was just his point. The only justification of it was that the money was taken as a means of stowing away the surplus.

Mr. MANLY contended that if a very large amount of that kind of business was done and the other business was decreasing, they would by that process soon exhaust the surplus funds belonging to the old policyholders.

Mr. KING thought the same argument applied to all new business.

Mr. MANLY thought not to such an extent. On the other hand, the business might not be so stable or they might be able to get some profit out of the surrender-values. There was no doubt there had been a strong endeavour to keep up the rate of interest by keeping down the value of securities, and that had been done with the object of keeping up a fixed rate of reversionary bonus. A difference of $\frac{1}{2}$ per-cent between the valuation rate and the rate earned was wanted to keep up a constant reversionary bonus, while a difference of 1 per-cent between the rate earned and the valuation rate was wanted to keep up a compound reversionary bonus, and the endeavour to keep up that rate of interest had, he thought, been largely with that object. He thought that by the constant or compound reversionary bonus system they were giving back to the older policyholders something of that surplus which had been reserved for the purpose. But, could that be kept up if future investments would not yield the same rate of interest? He would go a little further than Mr. King with regard to the care that should be exercised in considering the scheme, and one should make quite sure that it was possible for these policies to stand alone, and that the future average rate of interest would be at least sufficient to maintain a rate of bonus which they were calculating upon for a large number of years. He quite appreciated Mr. King's method of valuation. It had always occurred to him that that would probably be the best method of valuing those policies, but he could not get over the fact that only a certain small premium was being obtained, and that there was no opportunity of accumulating those premiums at a sufficiently high rate of interest to provide for a $2\frac{1}{2}$ or 3 per-cent valuation, unless drawings could be made from other funds, which would not be equitable as between the different classes of policies.

Mr. S. G. WARNER said he rose with some hesitation on account

of the very true remark made by the last speaker but one, that the discounted-bonus system had apparently come to stay. Under those circumstances it seemed in one sense rather useless as well as rather ungracious to find all possible objections one could to the system. At the same time, at the risk of incurring these reproaches, he should like to say a word or two on one practical aspect of the matter, and which presented itself to his mind as of great importance, namely, the obligation to the public which all those systems implied. the obligation on the part of the public to the offices, and the possibility, in fact, the practical certainty, that the latter set of obligations were not fully or properly understood. Those remarks applied only to systems by which any return for the reduction in premium power was taken by the offices to be exercised should events render it necessary to decrease the sum assured or increase the premium. He was very much afraid that taking such a step as that involved a good deal more than it might seem at first sight to imply. They had to consider how far-reaching the contracts they were making were, for how many years in the future they were pledged, and they ought to remember how uncertain the financial conditions of the future would be. how uncertain it was that the elements which had hitherto built up their profits would exist in the same form or to the same extent in the future as in the past. They had to take into consideration another great element which they, not as theorists, but as practical people who were trying to supply a practical demand and who lived by the British public, could not ignore, the curious fatality which seemed to prevent the average man from understanding the intricacies of life insurance contracts. Many of them had had experience of such a simple matter as a policy issued at a reduced premium for the first five years and a larger premium for the remainder of life. They knew the patience with which the underlying principles of the contract were hammered into the proposer's head when the proposal was taken, and the innocence with which, when the sixth payment came round, he tendered the same premium as during the first five years, and not only failed to appreciate the relief already given him, but seemed to think it was the result of a deep-laid conspiracy that he had to pay any more. With such experience, what were they to say about the somewhat complicated arrangement with regard to discounted bonuses? He could only say that he saw a very real danger foreshadowed by more than one of the speakers that evening in the position which would occur if and when any office found itself confronted with the necessity of acting upon those powers. He could readily conceive that very grave risks would be incurred, or that there would be a very serious temptation to incur them rather than to properly face the situation, because if on a large scale it were ever necessary for any office to exercise those powers, either in the way of reducing the sum assured or increasing the premium, however just it might be, or however obvious on the face of the contract, and however reasonable, it would shake public confidence in British life assurance, it would create such an impression as had never been known yet, and it would be a thing that would never be forgotten, the effect of which would be felt for many a day to come. In fact, it seemed to him that in

practically taking in that way policyholders into partnership, pledging to them an uncertain future, and involving the possibilities of making claims upon them, they were laying up for themselves the chance of serious trouble in days to come. They very often heard that they had to go to the public, find out what they wanted and give it to them, and that within certain limits was very true; but as they went to the public, surely it was very important indeed that they should preserve the public's implicit faith in the inviolability of the face-value of a policy. The extreme between theory and practice in the matter could not have been better illustrated than in the brilliant and ingenious putting of the case by Mr. King, who had said that two contracts were involved, a life assurance contract and a contract super-imposed upon it, for the sale of an annuity in exchange for an increasing reversion. When they could get those two contracts in the office, the one in the hands of the policyholder executed by the office, and the conveyance of the increasing reversion in exchange for it executed by him, in their own strong room, then he thought they might dismiss the fears with which he had been dealing, but so long as there was only one contract in the hands of the policyholder, which he did not rightly understand, so long they would run the risks which he had ventured to point out.

Mr. FREDERICK BELL wished to emphasize the remarks made by Mr. Warner. The great difficulty which he had pointed out seemed to him to be a very real one, although it was not very present to them now. The contracts were made for a very long period, and they should look to the other end of the contract period. He was perfectly aware that so far as the business had been done it had been carried out by most able members of their Institute with great care. But, as they had been told the system had come to stay, it would find imitators, and possibly some of those imitators might not imitate the care which had hitherto been exercised. It seemed to him that the danger would occur there, and should a British life office at any time have to go back on what the British public would regard as its contract, and ever have to raise the rate of premium or diminish the sum assured, he was afraid the prestige of British life assurance would very severely suffer.

Mr. JAS. CHISHOLM was glad to see that Mr. Moir at the outset of his paper sketched out the spirit and idea with which he approached it. He made plain that he was speaking, first of all, from the point of view of the actuary who was considering in his mind whether he should imitate this system; and, in the second place, from the point of view of the actuary who saw a system before him, and wished to consider how far he could reconcile all the existing interests that were involved. He had laid emphasis on that, because he thought the paper would be improved if it had a sketch of the idea with which the author started prefixed to it, and he hoped Mr. Moir would do that when the paper was published. In every respect in which he had looked at the question the author had shown that it was surrounded by so much delicacy of mechanism and so much difficulty in reconciling the classes of the contract that the feeling inevitably impressed on one's mind was that it was a most unwise thing to undertake the two systems in the same office—or, at least, as part

and parcel of one section in the same office. If the discounted-bonus system was to be done at all it should be done as a separate and distinct business, and run on distinct lines. In that respect he would make the only criticism on Mr. Moir's paper which he intended to make, namely, that it hardly, to his mind, corresponded to the title. The title on the paper was "On the Rationale of Discounted-Bonus Premiums." The author had written a very able paper, but he thought it would be better entitled "The Relations between Discounted Bonuses and a Reversionary Bonus System, and the Way in which the Two re-act on one another if conducted together." If they thought of the rationale that was an account of the principles that underlay discounted bonuses, he thought they would be led to take that wide conception of the whole subject, and, on thinking over the matter, it appeared to his mind that the differences between the two were insuperable. There were differences of principle, and there was no means of reconciling them, and the only thing they had to see was how far one could approximate to the other. He would give a wider conception to the term "discounted bonus" than was for the moment generally accepted as the meaning. They had all come to think of the term "discounted bonus" as the discounting of reversionary bonus, or a simple bonus, or a cash bonus, but that was not all. What was a bonus? A bonus, in speaking of insurance, was a benefit to be received at some future time, and when they discounted that bonus they gave up a future benefit for a present consideration in lieu of it. The widest conception of that discounting seemed to him to be carried out in the practice of those offices who did nothing but issue policies at a reduced or discounted rate of premium. They charged a certain large premium to begin with, but they discounted the whole future of the lifetime of the individuals who assured, and gave them such benefits in cash from day to day and from year to year as the current experience enabled them to give. Looking upon that as the widest conception of a discounted bonus, he would carry the illustration a little further by saying that he likened the two systems—the discounted-bonus system and the reversionary-bonus system—to two vessels each leaving the same shore to cross a wide and deep stream to the opposite side. The one vessel started with its gunwale level with the water; it did not want much margin; it reckoned on easy time, no storms, and absence of changes of all sorts—that was to say, that the rate of interest was supposed to be constantly approximating to the rate assumed. There were no disturbances, and everything went smoothly. The vessel sailed as near to the wind as possible, and was protected from danger by its ability to put up its moveable free-board at any moment—that is, to raise the premiums to the original level. The underlying principle was that expenses were cut down to the lowest margin, and profits approximated to as closely as possible, and that the assured obtained the resulting benefit immediately. In the other case, the reversionary-bonus system, it seemed to him that the vessel left shore with its free-board high out of the water. Every five years or at some other interval it put a little more cargo on board, and gradually sunk the vessel deeper and deeper until when it reached the other side it was pretty well in the same position as the other vessel; the loadings had worn off. In this

case the company, having its underlying principle in reversionary bonus additions, was in the position that it only had to refrain from doing something if there was danger ahead. It had not to take any special action by increasing its premiums, but simply to declare a bonus, which was not of such a large amount as before, and the disturbance to the terms of the contract was much less. Was there any mode in which these two systems could approximate to one another? He thought they could to a certain extent. Looking only at the profit that was made every five years, and dealing with that only, they could not reconcile the quinquennial distribution of profit with the distribution of a whole lifetime of profit, but they could from five years to five years give the assured the benefit of the reversionary bonus in a different plan. It could be done in two ways. It was done by offices that were known as carrying on what was called the discounted-bonus system, and in this respect he agreed with Mr. King. Where they gave a cash bonus, so long as the discounted bonus was made less than the cash bonus that would be given at the end of the quinquennium, so that it was wiped off and done with, that was perfectly legitimate, and they were not departing from the principle on which the office had been founded of distributing profits from five years to five years, and dealing only with profit after it had been earned. Then, again, they might give an increasing reduced premium—a reduced premium that gradually diminished according as the bonus increased. That, again, was governed by the amount of reversionary bonus given every five years. So far he believed that the system would be free from any objection, and would need no other safeguards than those imposed by the original system of the office. He did not know that there was much further to be said in regard to the remarks which had been made. The speakers had shown that they were fully sensible of the danger run by conducting business on the discounted-bonus plan, and that it needed very great care and caution in carrying it on. Mr. King referred to the fact that there were really two contracts involved, and that the giving of a reduced premium was equivalent to selling an annuity for a reversion. The difficulty that occurred to his mind was that they might never get the reversion, which was the whole point. A man obtained his reduced premiums, but if the bonus was not kept up the reversion was never obtained and no *quid pro quo* was forthcoming.

MR. KING said it was charged on the sum assured.

MR. CHISHOLM said that everything Mr. King said was entitled to be taken with the very greatest respect. They all wished to study the principle that gentleman had enunciated, but at the present time he could not see that there was any way of looking at it other than that adopted by Mr. Manly, who said it was no use trying to juggle with facts. In the one case they had a large premium, and they said "Let us go along cautiously from five years to five years, and if we have made anything in the five years let us divide it." In the other case a very small premium at 4 per-cent or $3\frac{1}{2}$ per-cent was obtained. They could not make any more out of that than it would yield, and it was no use trying to give the people more than that $3\frac{1}{2}$ per-cent premium accumulated out of its own investments, which had to be made at the current rates of interest. A system where one looked forward to

giving increased compound reversionary bonuses and dividing only from five years to five years what was made, and another system where it was found necessary to value at a higher rate of interest so as to adhere to a discounted premium originally assumed, he could not see any possible means of reconciling.

On the motion of the **PRESIDENT**, a very hearty vote of thanks was accorded to Mr. Moir for his paper.

Mr. **MOIR**, in reply, thanked the members for the hearty reception accorded to his paper, and the friendly criticisms which had been made. With regard to the rate of interest to be assumed in calculating premium rates, Mr. Sorley had indicated that $3\frac{3}{4}$ per-cent was too high and that $3\frac{1}{2}$ per-cent was as much as offices could reasonably assume at present. In suggesting $3\frac{3}{4}$ per-cent he, (Mr. Moir) had in view the fact that several wealthy offices conducting their business for fifty or sixty years had during all that time earned practically 4 per-cent interest, and were still doing so. It might be that, to a certain extent, they were getting their interest from investments made many years ago, which had since appreciated; but amongst the other steps which some of them had taken was the extending of their powers of investment. He knew that one or two offices had maintained their rate of interest, not from the old investments, but from the new classes of securities which they now secured. The general reduction in the rate of interest was partly to be accounted for by one or two large conservative offices adhering to the old classes of investments, which now yield only a small return. Mr. Sorley had pointed out that the premium rates, intermediate between Full and Non-Profit, suggested in the paper, would probably not "produce appreciably higher premiums than the non-profit class" if any bonuses had been added to the sum assured, seeing that the premium would have to cover the sum assured and declared bonuses. The bonuses might, however, be held to stand by themselves, as a proper reserve would have been made for them at the time of declaration. Moreover, there was no particular reason for an office guaranteeing the bonuses, which might be declared subject to diminution if future bonuses fell below the anticipated amount, so that an adjustment would be possible. All that he (Mr. Moir) stipulated for was a guarantee of the sums assured. He had some little difficulty in fully grasping the double contract system proposed by Mr. King. He thought there might be trouble in getting policyholders to accept the policy if the full premium were inserted; and, moreover, the office would scarcely be entitled in extreme circumstances to raise the premium beyond the full rate, although in theory that step might be necessary.

The Effect of Using the Lapse Element in calculating Premiums and Reserves. By ARTHUR HUNTER, F.F.A., A.I.A., of the New York Life Insurance Company, New York.

[Read before the Institute, 28 January 1901.]

SO far as I have been able to discover, very little has been written on the effect which the allowing for the lapse element has on premiums and the corresponding reserves. In Mr. T. G. Ackland's paper, reported in vol. xxxiii, part II of the *Institute Journal*, he treats of the "Effect of an Estimated Allowance for Withdrawals upon the Net Premiums and Valuation Factors computed, and upon the Reserves on Net Liability", and shows the effect which a certain assumed lapse rate has on the premiums and reserves, but does not show what effect there is when the lapse rate is increased or diminished. The province of this paper is to show the *general effect* of lapse rate, and whether a larger element of lapse in the calculation increases or decreases the corresponding reserves.

The subject is of general interest in Britain, because the lapse element is particularly applicable to Friendly Societies, and has been taken into consideration by a number of actuaries in their calculations for such societies. The most recent account of experiment on these lines is given in Mr. Ackland's paper, to which reference has already been made. The subject is at present of particular interest to American actuaries, because of the use which is being made of the lapse element by the managers of the Assessment Companies and of the Fraternal Orders in their efforts towards transition from the unsafe basis of assessmentism to a basis at least fairly safe and scientific. Many of them are at the point where they think favourably of adopting a premium which, by taking the lapse element into account, would, though higher than their present rate, still be lower than that charged by the old-line companies.

The best and simplest expression of opinion which I have found on the subject is given in Mr. George King's popular lecture, entitled, "Facts, Fallacies, and Fancies in Life Insurance", and is as follows:—

"The company which takes account of discontinuances in calculating its premiums, requires to make—and I can prove it by mathematics—a considerably higher reserve than a company charging the ordinary level premiums. Therefore it is utterly fallacious for assessment or natural premium offices to argue that because they

trust to discontinuances they do not require large reserves. A premium calculated to allow for discontinuances is naturally lower than the premium calculated for mortality only, because the surrender-values of the policies which it is assumed will lapse are applied in reduction of premium. Now it is found that discontinuances take place in great proportion in the early days of the policies, and that when policies have been in existence, say, ten or fifteen years, discontinuances practically cease. All the discontinuances take place in the early years, and when a man has kept up a policy for a certain time he keeps it up to the end. Now the premium being lower than the ordinary level premium, and the risk being the same, and the premium being part of the assets relied upon by the office in order to meet the claim, it follows that the other part of the assets, namely, the reserves, must be increased. So that if the premium is reduced by the application of lapses to lower the premium, then the reserves, on the other hand, must be increased, so as to get a perfect balance between the liabilities and assets. Now by these simple considerations you can see that a company which trusts to discontinuances in order to reduce its rates must, if it is to remain permanently solvent, make larger reserves than a company which charges the ordinary premium based upon mortality only."

In contradistinction to Mr. King's clear-cut and logical statement of the facts, it may be interesting to give an illustration of the illogical manner in which the assessment managers have convinced themselves, and incidentally the policyholders, that an allowance for discontinuances materially decreases the reserve. It was my first intention to give quotations from the various pamphlets issued by several assessment companies, but the following imaginary conversation may be more satisfactory. It is not an extract from any one company's pamphlets; I have compiled it as a model from several which it has been my lot to read.

Q.—What elements do the old-line companies use in calculating premiums?

A.—The rate of interest and the rate of mortality.

Q.—Is there not another element which enters into the practical calculation of the premium?

A.—Yes; there is the lapse element, but that is not used by the old-line companies, who assume that the members will only fall out by death.

Q.—If that element were used, would it not reduce the premium?

A.—Yes. By using the lapse element, the premium would be considerably reduced. It is actuarially correct, and has been used satisfactorily on a number of occasions.

Q.—Would the reserve or accumulations be reduced if the lapse element were used?

A.—Undoubtedly. As the expectation of life at age 35 is about 31 years, and the average life of a policy is only about 10 or 12 years, it naturally follows that the accumulation or reserve can be cut down to a very large extent.

An apology is doubtless necessary for inserting such colloquial language in the dignified pages of the *Journal*, but it is the only effective way in which I can convey the train of reasoning used by many assessment advocates. If we put ourselves in the position of a man who does not understand the elements of life insurance, it must be admitted that the above conversation will appeal very strongly to him. With the exception of the answer to the last query, the foregoing imaginary conversation is actuarially correct. It is not a fact that the reserve with the lapse element is generally less than without it.

The premiums used by many assessment managers were copied from the rates of one company, whose lead in many matters was followed by most of the others. These rates were too low, because the assumed rate of mortality was light and the estimated rate of lapse was heavy. Had satisfactory rates of mortality and a moderate rate of lapse been used in calculating the premiums, there would have been no objection to the experiment, provided no surrender-values were allowed. It is only fair to state that most of the managers of these companies realized that the premiums were too low before it was too late, and are endeavouring to change to the old-line basis.

One assessment manager, on whom most of the companies relied for their actuarial information, published the results of an investigation into the effect which discontinuance had on premiums and reserves. It was shown conclusively that the reserves were fully as large as when lapse was not taken into account. He made an error in logic, however, his argument involving the assumption that, while the reserve with lapse requires to be maintained only for those who at any given moment are members of the company, the reserve without lapse must be maintained *for everyone* who has ever been a member of the company and who is now living. The following is an extract from his paper:—

“A cursory examination of the policy-values, according to the several tables, gives the impression that an association whose

premiums are based on the Decrement Table must have a larger accumulation than a Company whose premiums are based on the Mortality Table. This is, of course, a mistake. It is true that the accumulations for existing policies must be greater; but there are practically no accumulations belonging to the discontinued policies. To illustrate this, and make it perfectly clear, I will subjoin another table. In this table, we will assume to insure 100,000 persons at age 40, according to the mortality experience of the Companies. We will also insure the same number of persons according to the Decrement Table, which, as already explained, is made up from the same data, but includes the lapses. The number exposed and values in this table are given in cycles of ten years. It will be noticed that according to the Mortality Table, the number exposed the tenth year is 91,135, that the value of each policy is \$160.39, and of all the policies \$14,617,143. But according to the Decrement Table, there are not 91,135 insured the tenth year, the number being only 41,205, and this is in accordance with insurance experience. The value of each individual policy on the Decrement basis is \$164.37, nearly \$4, more than on the full premium basis; but the aggregate accumulation is only \$6,772,866, or only 46 per-cent of the full premium accumulation. . . . Is any further proof needed to show the fallacy of collecting money used in advance of an expected contingency which experience shows has never happened, and in all probability never will happen? That contingency is, that every policy issued will become a claim by death. Should that ever happen, and if anyone can show that it ever has happened, then we would grant that the only correct system of life insurance would be on the basis of the Mortality Table and interest alone."

In order that the foregoing may be readily understood, the table to which the author refers is subjoined.

Table showing 100,000 Persons aged 40 Insured on the Basis of the Mortality Premium and Decrement Premium respectively.

Completed Years of Insurance	Exposed according to Mortality Table	Exposed according to Decrement Table	INDIVIDUAL POLICY-VALUES PER \$1,000		TOTAL POLICY VALUES	
			Mortality Premium	Decrement Premium	Mortality	Decrement
			\$	\$	\$	\$
0	100,000	100,000	...	...	...	...
10	91,135	41,205	160.39	164.37	14,617,143	6,772,866
20	77,765	27,922	364.26	398.72	28,326,679	11,133,060
30	53,532	18,884	584.27	611.69	31,277,142	11,551,154
40	17,997	6,346	770.31	787.41	13,863,270	4,996,904
50	580	205	884.85	926.72	513,213	189,978

The error in reasoning lies in the assumption that a reserve must be carried in Old Line companies, even on those policies which have been lapsed, *e.g.*, the assumption is that an Old Line

company, starting with 100,000 members, and having at the end of ten years only 41,205 members, would at that time be holding an aggregate reserve of \$14,617,143, while a company of the new style would need to be holding only \$6,772,866.

Unfortunately no eminent actuaries in the United States, whose word would have carried weight with the public and with the Assessment Managers, contradicted the erroneous statements regarding the necessary reserve. Had it been forcibly pointed out that the surrender-value of the Old Line contracts was, or should be, the equivalent of the higher premiums, these fallacies would not have been so widely accepted. Under the old Tontine system, where the reserve was forfeited in case of discontinuance, no satisfactory answer could be made to the charge that in case of lapse a proper equivalent was not given to the policyholder for the higher premium. Now-a-days, the surrender-values are so liberal, being in many American companies equal to the full legal reserve after the first two or three years, that there is no good reason for taking the lapse element into account, except for Friendly Societies, Fraternal Orders, and similar institutions.

I shall now give the results of my investigations, with a brief explanation of the working methods. It has been my duty to prepare for practical use, while connected with another company, tables based upon lapse and mortality. In order to save unnecessary work, it has been my custom to prepare tables at each fifth age, construct the necessary premiums and reserves therefor, and then interpolate for all values at intermediate ages. Even the work for every fifth age is extremely laborious. By simple artifice, however, the work can be very materially lessened. As the lapse rate after the first few years has very little effect on either the premium or reserve, we may assume that the policies only go out by death after a certain policy year, *i.e.*, lapsing terminates at a certain point. For instance, at age 25 the rate of lapse is very small after the 15th year, and there is accordingly a very slight effect from the conservative measure of discontinuing the use of the element of lapse in the calculation after 15 years. Similarly, at age 60 it is advisable to assume that there would be no lapses after the 10th policy year. While it is more in accordance with the facts to continue the use of the lapse element to the 15th year at age 25 and to the 10th year only at age 60, it has been found more satisfactory for the purposes of this paper to discontinue its employment after the 10th year at all ages. The regular commutation columns which take

into account only the factors of interest and mortality, have been utilized in obtaining similar columns, including the lapse element, without an undue amount of labour in the following way :—

The H^M rate of mortality has been used, and a slightly graduated lapse rate which has been taken from the same experience. The lapse rate, accordingly, depends upon the age at entry and decreases with advancing age. It would have been more precise to use a select table, but the H^M serves the avowed purposes of this paper. The deaths are supposed to take place at the end of the year, and a similar assumption has been made regarding lapses : in other words, it is assumed that all the entrants pay annual premiums throughout. The results are practically the same as if the assumption had been that the lapses and deaths occur on the average in the middle of the year. Starting with 100,000 entrants we multiply by the rate of mortality, thus obtaining the number of deaths, and also by the lapse rate, thus obtaining the number of lapses for the year. Adding these two numbers together we have the total number of discontinuances, which, subtracted from the number of entrants of the first year, gives the number entering on the second year. This method was continued until the end of the 10th year. As lapse was assumed to cease after 10 years, there would be only the two elements of interest and mortality after that period. In order to save the labour of carrying the work out to the limiting age of the Mortality Table, the numbers for the first ten policy years were altered in the ratio which the number living at the attained age according to the H^M Table without lapse, bore to the corresponding number in the H^M Table with lapse. An example taken from Exhibit A, age at issue 25, will make the method clear. The number beginning the 11th policy year is 36,586, while the number of living according to the H^M Table at attained age (35) is 86,281. The columns of Entrants and Deaths have, therefore, been increased in the proportion of 86,281 to 36,586, giving 235,835 entrants in the first policy year at age 25, instead of 100,000. On constructing Commutation Columns from these new figures it naturally follows that the Commutation Columns of the H^M Table are identically the same as those which are needed for our purpose from and after the 11th policy year. It is hardly necessary to point out the saving of labour gained by this artifice, which is fully elucidated in the working exhibit.

EXHIBIT A.

Life and Commutation Tables based on H^M Mortality and Double Lapse Rate.—Age at Issue 25.

Policy Years	No. paying Premiums = Entrants	q_x	Deaths	Lapse Rate per-cent	Lapses	Lapses and Deaths
1	100,000	·00663	663	18	18,000	18,663
2	81,337	·00669	544	14	11,387	11,931
3	69,406	·00690	479	12	8,329	8,808
4	60,598	·00717	434	10	6,060	6,494
5	54,104	·00743	402	8	4,328	4,730
6	49,374	·00772	381	7	3,456	3,837
7	45,537	·00792	361	6	2,732	3,093
8	42,444	·00811	344	4	1,698	2,042
9	40,402	·00829	335	4	1,616	1,951
10	38,451	·00850	327	4	1,538	1,865
11	36,586	...	...	...	...	...

Entrants Deaths and Lapses increased in the Ratio which the Number living at Age 35 by H^M without Lapse bear to the Entrants at the beginning of the 11th Policy Year (Age 35).

Policy Years	Entrants	Deaths	Lapses
1	235,835	1,564	42,450
2	191,821	1,283	26,855
3	163,683	1,129	19,642
4	142,912	1,025	14,291
5	127,596	948	10,208
6	116,440	899	8,151
7	107,390	851	6,443
8	100,096	812	4,004
9	95,280	790	3,811
10	90,679	771	3,627
11	86,281	...	...

Policy Years	C_x	D_x	M_x	H_x	A_x	a_x
1	449·3	69,770	16,507·2	1,066,246·3	·23659	14·282
2	397·5	61,192	16,057·9	996,476·2	·26242	15·284
3	367·6	54,853	15,660·4	935,283·9	·28549	16·051
4	345·8	49,693	15,292·8	880,430·2	·30774	16·717
5	327·9	45,487	14,947·0	830,737·1	·32860	17·263
6	315·2	42,067	14,619·1	785,249·6	·34752	17·666
7	300·6	39,098	14,303·9	743,181·7	·36585	18·008
8	287·7	36,520	14,003·3	704,083·7	·38344	18·279
9	277·5	34,459	13,715·6	667,563·7	·39802	18·372
10	268·3	32,509	13,438·1	633,104·2	·41336	18·475
11	261·2	30,662	13,169·8	600,595·0	·42950	18·587

As this paper undertakes only to show in a general way the effect of the lapse rate on premiums and reserves, not to furnish

tabulations of the exact amount of such effect, the following exhibits contain only the results of investigations at ages at issue—25, 40, and 60. The following exhibit (B) gives the net premiums for the three ages selected, on the 10-Year Term, Ordinary Life, 10-Payment Life, and 10 and 20-Year Endowment Assurance plans. In addition to the net premiums obtained by using the graduated H^M lapse rate, the net premiums resulting from the use of a double lapse rate are also given. It has always been recognized by actuaries that the employment of the lapse factor would decrease the net premiums, and the comparative net premiums derived from the use of the lapse factor, as carried out in Exhibit B, show that this is the case, but hardly to the extent which many have supposed.

EXHIBIT B.

Net Premiums per £1,000. *H^M Mortality and Lapse Rates—Interest 3 per-cent.*

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
10-YEAR TERM			
	£	£	£
25	7.25	7.17	7.08
40	11.73	11.59	11.44
60	39.53	38.81	38.06
ORDINARY LIFE			
25	16.25	15.48	14.56
40	25.89	24.83	23.66
60	59.87	57.64	55.25
10-PAYMENT LIFE			
25	42.01	35.45	29.37
40	56.16	49.80	43.80
60	89.15	82.38	75.81
20-YEAR ENDOWMENT ASSURANCE			
25	40.58	36.54	32.15
40	43.73	40.75	37.60
60	65.08	62.26	59.29
10-YEAR ENDOWMENT ASSURANCE			
25	88.17	73.02	58.98
40	90.21	79.09	68.60
60	103.39	94.89	86.64

The following exhibits give the comparative policy reserves on the three hypotheses for the end of each policy year from the first to the tenth inclusive. The first exhibit (C) gives the reserves under a 10-Year Term policy. It will be seen that the variations in reserves are very small. The lapse element slightly decreases the first year's reserve at the young ages in the first policy year, but thereafter there is a decided tendency in the reserve to increase, resulting both from the normal and double the normal lapse rates.

EXHIBIT C.

Net Reserves per £1,000.—10-Year Term.

H^M Mortality and Lapse Rates—Interest 3 per-cent.

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	·84	·83	·81	1·66	1·67	1·68
40	1·78	1·73	1·67	3·47	3·46	3·43
60	11·37	11·43	11·45	21·06	21·47	21·84
	3RD YEAR			4TH YEAR		
25	2·29	2·36	2·43	2·67	2·81	2·94
40	4·98	5·03	5·04	6·14	6·23	6·29
60	28·77	29·85	29·88	34·14	35·18	35·99
	5TH YEAR			6TH YEAR		
25	2·81	2·99	3·16	2·66	2·87	3·06
40	6·93	7·07	7·23	7·12	7·37	7·59
60	36·97	38·18	39·41	36·97	38·29	39·69
	7TH YEAR			8TH YEAR		
25	2·31	2·51	2·70	1·75	1·91	2·06
40	6·56	6·83	7·04	5·20	5·44	5·63
60	33·80	35·20	36·67	26·99	28·18	29·42
	9TH YEAR					
25	·99	1·08	1·18			
40	3·05	3·22	3·33			
60	16·14	16·82	17·56			

The reserves under Ordinary Life policies appear in the next exhibit. With the exception of the first year, the introduction of

the lapse element into the calculation increases the reserve. It is needless to give the reserve beyond the tenth year, because the reserve with lapse must be larger than the reserve without lapse by the difference in the net premium multiplied by the Whole-Life annuity at the attained age (the lapses are assumed to cease at the end of the tenth policy year).

EXHIBIT D.

Net Reserves per £1,000—Ordinary Life.
H^M Mortality and Lapse Rates.—Interest 3 per-cent.

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	10·18	10·30	10·29	20·67	21·53	22·16
40	16·53	16·45	16·14	33·56	34·06	34·33
60	32·97	32·97	32·79	65·69	66·77	67·57
	3RD YEAR			4TH YEAR		
25	31·34	33·45	35·43	42·15	45·86	49·64
40	51·05	52·59	53·89	68·89	71·55	74·02
60	98·10	99·97	101·48	130·10	133·88	137·33
	5TH YEAR			6TH YEAR		
25	53·11	58·53	64·32	64·22	71·57	79·73
40	87·08	91·56	95·87	105·45	112·39	119·61
60	161·80	167·82	173·64	193·29	201·57	209·85
	7TH YEAR			8TH YEAR		
25	75·57	84·97	95·69	87·17	98·11	110·79
40	123·94	132·79	142·16	142·58	153·81	166·00
60	224·65	236·15	247·94	255·94	270·25	285·18
	9TH YEAR			10TH YEAR		
25	99·06	111·87	126·95	111·21	126·27	144·25
40	161·41	175·62	191·34	180·45	196·20	213·68
60	287·35	303·68	320·92	318·57	335·75	353·94

In the next Exhibit (E) is shown the reserves under 10-Payment Life policies. Particular attention is drawn to this Exhibit, as the reserves are less with lapse than without it, except

towards the end of the payment period. The turning-point appears to come in the seventh year at the older ages, and at the ninth year at the younger ages.

EXHIBIT E.

Net Reserves per £1,000.—10-Payment Life.
H^M Mortality and Lapse Rates.—Interest 3 per cent.

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	36·89	33·08	29·04	75·08	69·20	62·67
40	48·04	44·08	40·03	97·88	91·76	85·27
60	64·04	61·28	58·28	129·91	126·29	122·22
	3RD YEAR			4TH YEAR		
	£	£	£	£	£	£
25	114·49	108·11	100·67	155·13	149·23	141·99
40	149·54	142·30	134·41	202·96	194·72	185·63
60	197·85	192·75	187·04	268·17	263·68	258·44
	5TH YEAR			6TH YEAR		
	£	£	£	£	£	£
25	197·09	191·90	185·27	240·41	236·56	231·34
40	258·35	250·73	242·13	315·62	310·46	304·24
60	341·43	338·14	334·07	418·23	416·08	413·23
	7TH YEAR			8TH YEAR		
	£	£	£	£	£	£
25	285·23	282·98	279·60	331·64	329·12	325·80
40	374·81	370·33	364·85	436·17	433·64	430·31
60	499·29	500·15	500·46	585·41	588·30	590·87
	9TH YEAR			10TH YEAR		
	£	£	£	£	£	£
25	379·72	377·91	375·67	429·52	429·52	429·52
40	499·89	500·76	501·19	566·13	566·13	566·13
60	677·63	680·60	683·50	776·99	776·99	776·99

The next Exhibit (F) shows the reserves on 20-Year Endowment assurances. It appears that, generally speaking, higher Reserves must be held when the lapse rate is used in the calculation. The large Reserve is especially noticeable with a high lapse rate. For instance, at the end of the 10th year, the Reserve at age 25 with mortality and interest alone is £411·86,

whereas, with the additional factor of twice the normal lapse rate, the Reserve is £483·09.

EXHIBIT F.

Net Reserves per £1,000.—20-Year Endowment Assurances.

H^M Mortality and Lapse Rates.—Interest 3 per-cent.

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	35·40	34·32	32·56	72·06	71·80	70·27
40	35·12	34·02	32·64	71·47	70·85	69·59
60	38·49	38·26	37·80	77·11	77·89	78·30
	3RD YEAR			4TH YEAR		
25	109·87	112·20	112·93	148·86	154·89	159·33
40	109·14	109·78	109·62	147·97	150·08	151·27
60	115·83	117·30	118·28	154·65	158·12	161·11
	5TH YEAR			6TH YEAR		
25	189·10	199·19	207·98	230·63	245·58	259·81
40	188·04	192·97	197·07	229·35	238·67	247·40
60	193·74	199·63	205·15	233·29	241·63	249·80
	7TH YEAR			8TH YEAR		
25	273·59	293·80	314·13	318·07	341·74	366·17
40	271·82	284·24	296·29	315·61	332·22	348·95
60	273·49	285·45	297·55	314·53	329·65	345·23
	10TH YEAR			15TH YEAR		
25	411·86	446·06	483·09	677·84	696·51	716·80
40	407·77	431·97	457·60	670·99	684·45	698·17
60	400·10	418·16	437·07	637·93	648·77	660·19

In my original paper, Exhibits were only given for 10 and 20-Year Endowment Assurances, but as it was found that the trend of the Reserves under the latter were different from those under the former, an Exhibit (G) for the 15-Year Endowment Assurances is now given. It will be noticed that the Reserves with lapse are less than those without lapse at all ages of entry up to the fourth policy year. At that point a change takes

place—the Reserve at age 25 being greater with lapse than without it; whereas the converse holds good at age 40. From the fifth and succeeding years the Reserve is greater with the lapse element than without it.

EXHIBIT G.

*Net Reserves per £1,000.—15-Year Endowment Assurances.
H^M Mortality and Lapse Rates.—Interest 3 per-cent.*

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	51·53	48·68	44·91	105·02	101·86	96·95
40	50·78	48·28	45·44	103·31	100·51	96·85
60	49·80	48·89	47·71	100·44	100·24	99·55
	3RD YEAR			4TH YEAR		
25	160·21	159·27	155·90	217·28	220·07	220·15
40	157·87	155·90	152·71	214·35	213·41	210·99
60	152·13	152·14	151·55	204·86	206·86	208·20
	5TH YEAR			6TH YEAR		
25	276·23	283·29	287·63	337·31	349·61	359·65
40	272·86	274·88	275·29	333·39	340·51	346·19
60	258·96	263·59	267·52	315·06	322·19	328·86
	7TH YEAR			8TH YEAR		
25	400·53	418·66	435·23	466·13	487·41	507·76
40	396·12	406·38	415·45	461·13	476·11	490·37
60	373·24	384·59	395·71	434·26	449·08	464·06
	10TH YEAR			13TH YEAR		
25	604·67	637·24	670·94	832·71	846·44	860·81
40	598·88	622·27	646·10	828·43	838·46	848·75
60	566·88	583·84	601·54	801·85	809·61	817·70

It is interesting to study the following Exhibit (H) on the 10-Year Endowment Assurance plan with that of the 20-year Endowment plan. The former shows a different trend in the Reserves from the latter with the exception of the first policy year.

EXHIBIT H.

*Net Reserves per £1,000.—10-Year Endowment Assurances.
H^M Mortality and Lapse Rates.—Interest 3 per-cent.*

Age	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate	Mortality alone	Mortality with Normal Lapse Rate	Mortality with Double Lapse Rate
	1ST YEAR			2ND YEAR		
	£	£	£	£	£	£
25	84.75	75.91	66.53	172.58	158.89	143.66
40	83.50	76.50	69.42	170.19	159.45	148.00
60	79.16	75.59	71.73	161.15	156.39	151.02
	3RD YEAR			4TH YEAR		
25	263.50	248.59	231.16	357.61	343.74	326.68
40	260.29	247.52	233.56	353.75	339.21	323.08
60	246.37	239.67	232.13	335.34	329.32	322.26
	5TH YEAR			6TH YEAR		
25	455.11	442.84	427.14	556.16	546.98	534.53
40	451.04	437.43	422.15	551.97	542.79	531.58
60	428.81	424.27	418.60	527.65	524.51	520.40
	7TH YEAR			8TH YEAR		
25	660.97	655.53	647.36	769.76	763.76	755.78
40	657.00	648.98	639.07	766.44	761.87	755.78
60	632.88	633.65	633.52	745.67	749.11	751.95
	9TH YEAR			10TH YEAR		
25	882.70	878.44	873.07	1,000.00	1,000.00	1,000.00
40	880.65	882.15	882.73	...	...	...
60	867.47	871.17	874.56	...	...	...

In the case of the foregoing Exhibit (H), the relative Reserves under 10-Year Endowment Assurances are similar in character to those under 10-Payment Life policies, the Reserves with lapse being less than the Reserves without it, except in a very few cases.

A general survey of the various Exhibits which have been submitted leads one to believe that the employment of the lapse element is dangerous, except in the hands of experienced actuaries. The fact that the reserve in the first two or three years is generally less with lapse than without it, may mislead

many of the laity into arguing that it will always continue smaller. On the contrary, it is evident from the results worked out that the excess of the reserves required by the use of the lapse element may become a serious matter, making the holding of merely an ordinary tabular reserve no sufficient test of solvency for a company using the lapse element. In the early years of such a company the regular reserve would be sufficient, but the older the company the greater would be the deficit in the true reserve.

In order to show the practical working of the two plans, the reserve has been calculated at the end of the first policy year, at age 25, on 10-Year Endowment Assurance policies. The process will further serve to prove that the reserve of the members who discontinue must be left in the "pool" when lapse is allowed for in the calculation, and that it is taken out of the "pool" and applied to other purposes when no allowance is made for lapse.

WITH LAPSE.

Age 25.—10-Year Endowment Assurance.—Premium £58·98 per £1,000.

Premiums on 100,000 Persons at £1,000 each .	£5,898,000
3 per-cent Interest	176,940
	<hr/>
Premiums plus Interest	6,074,940
Death Losses at Rate of £6·63 per £1,000 .	663,000
	<hr/>
	£5,411,940
	<hr/>

Number remaining at beginning of Second
Year, after deducting Deaths and Lapses . . . 81,337
Share of each Entrant into Second Year =
Reserve per Member at end of First Year . . £66·53

WITHOUT LAPSE.

Age 25.—10-Year Endowment Assurance.—Premium £88·17 per £1,000.

Premiums on 100,000 Persons at £1,000 each .	£8,817,000
3 per-cent Interest	264,510
	<hr/>
	9,081,510
Death Losses at Rate of £6·63 per £1,000 each	663,080
	<hr/>
	£8,418,510
	<hr/>

Number remaining at beginning of Second
Year, after deducting Deaths . . . 99,337
Share of each Entrant into Second Year =
Reserve per Member at end of First Year . . £84·74

There is no doubt that the lapse or withdrawal element may be used very effectually for calculating premiums and reserves for Friendly Societies, and also for sickness plans, such as are used by railroad and other corporations. Where no surrender-values are to be given it is only just that an assumed rate of withdrawal, as high as is safe, should be employed in calculating the premiums, and in such case it must also be used in fixing the corresponding reserves.

In doing actuarial work for a Society which has been in existence for some time, the experience of that Society is, undoubtedly, the best guide. The rate of lapse depends as much as the rate of mortality upon the various elements which enter into the constitution of the Society. If the Society seeking the advice is new, the greatest care must be exercised in estimating the expected rate of withdrawal. The best guide is the experience of a similar Society, where the conditions which surround the members are the same as to habitat, employment and social status.

So far as my observation goes, there is not a great deal of fluctuation in the lapse rate over cycles of, say, 10 years. The individual years are affected by the business prosperity, or commercial depression, of the country, but the average lapse rate according to age for one cycle is not very different from that of the succeeding cycle. This would especially apply to Societies where the business policy of the management has not changed. Of course, if there be an increase in the premiums, a loss of confidence in the management, or more stringent treatment of the members, there is certain to be an increase in the rate of withdrawal. It should be borne in mind, however, that an increased rate of withdrawal means that the premium charged has been too high, while the corresponding reserve is usually too low. One exercises, to a certain extent, a counterbalancing influence on the other. Unless the rate of lapse were materially greater or less than that assumed in the calculations, no change would be advisable until a few more years of experience had been obtained. If the lapse rate were less than assumed in the calculation, then an increase in the premium would shake the confidence in the management, and would result in a lapse rate which would undoubtedly be larger than had been provided for in the original calculations.

Among the Fraternal Orders in America there has been only one attempt to take the lapse rate into account in a proper

fashion. All other Societies which have put forth claims to making use of the lapse element have done so in a blind or utterly untrustworthy method. For instance, it was common to make a rough calculation at one age to find the approximate ratio which the premium with lapse bore to the premium without lapse, and then apply the same ratio at all ages. Even that method was better than the majority of methods, which were usually mere guess-work based on the judgment of the management.

If it is necessary to use the lapse element for the salvation of Societies, or to meet certain conditions of sickness and insurance plans, the calculations can be safely undertaken only by skilled actuaries.

DISCUSSION.

Mr. H. M. TROUNCER thought he should be lacking in courtesy if he did not acknowledge the consideration and kindly feeling which had prompted the President to give him, as one of the junior members of the Institute, the opportunity of opening the discussion. Mr. Hunter, in his interesting paper, had set out to show the general effect of lapse rate, and whether a larger element of lapse in the calculations increased or diminished the corresponding reserves. The tables worked out were based on the H^M Experience both with regard to mortality and lapse. The lapse rate was assumed to cease after ten years, and the author had applied this rate, deduced from the general experience, to various classes of assurance. The author's arguments and methods were very clearly expressed, and a great deal of labour had been saved by working on to the values of the H^M commutation columns from and after the eleventh year. Turning to the table giving the reserves for whole-life policies, the most important class, it would be seen that by taking the lapse element into the calculations the reserves increased practically throughout, with the exception of the first year. It was interesting to note that the reserve approximately increased in proportion to the lapse rate, that was to say, by *doubling* the rate the difference between the reserves with and without the element of lapse was doubled. No comparison between the increases in the reserves at different ages would be of much use, seeing that the rate of lapse varied so considerably with the age. For instance, at age 25 the lapses were very much more numerous than at age 60, and consequently the difference in the reserve was much more noticeable. At age 25, taking the difference between the reserves, with and without the element of lapse, the percentage of this difference increased from 7 per-cent of the normal reserve in the second year to 14 per-cent in the tenth year. In other words, the difference became more and more marked up to the tenth year. After this period, as the lapses were assumed to cease, the difference in the reserves would be the difference in the premiums multiplied by the annuity due, which was a diminishing quantity, so that the maximum would occur in the tenth year, and

Mr. Hunter's statement that in the early years of a company the regular reserve would be sufficient, but the older the company the greater would be the deficit of the true reserve, needed some qualification. Turning to the ten-year term, the results were fairly uniform. The reserves practically increased throughout and the differences were very small, but it must be remembered that after the sixth or seventh year the reserves were decreasing, and consequently the percentage of the difference was effective, amounting to 10 per-cent of the normal reserve in the seventh, eighth, and ninth years. The author had pointed out the fact that the reserve for the ten-payments life plan decreased instead of increasing, and also the curious effect in the endowment assurances that in the 20 years' table the difference in the reserve increased, while in the 10 years' table it decreased. It seemed to vary considerably with the term, but would also be affected, he thought, by other considerations, such as the incidence and amount of the lapses. The author had taken the general lapse rate from the H^M Experience, and had applied it to the various classes of assurance. He thought that the incidence of the lapse rate was likely to vary very considerably with the various classes of assurance, and that it would be advisable before it was applied to any of these tables to have a thorough and separate examination of each class. For instance, comparing the 10-year term with the limited-payment policy, in the former case the yearly premium being small, and practically covering the year's risk, one might expect the lapses to be more uniform throughout the term. In the latter case, one might expect the lapses to be smaller and to decrease very rapidly, seeing that each payment covered so much more than the current risk, and that, as no surrender-values would be given, the assured would be throwing away a great deal in letting his policy lapse. The author said that the best guide in applying the principle to any particular society was the experience of that society itself. To illustrate the danger of using the lapse rate, suppose that a society lowered its rates by using the lapse element in its calculations; it was quite conceivable that the premiums being lowered the rate of lapse in that society would be considerably affected. With regard to fraternal orders and other societies where it might be necessary, in order to establish themselves on a firmer basis, to use very low premiums, he would suggest whether it would not be possible, instead of reducing the premiums throughout life, to reduce them only during the term for which lapses were effective. On Mr. Hunter's assumption this period would be 10 years, after which, of course, the reserves would be normal and the difficulty and uncertainty of an increase in the reserves would be got rid of; there would be less break in passing to the uniform premium, and in 10 years' time he thought the members of a society would become more reconciled to the change. He did not know whether the plan was at all feasible, but he merely suggested it for consideration.

The PRESIDENT said he supposed Mr. Trowner suggested that a surrender-value should be allowed after ten years but not before that time?

Mr. TROWNER replied in the affirmative. He thought everyone would agree that the suggested use of the lapse rate was a dangerous

weapon to put into anybody's hands, and he did not think anyone present would disagree with Mr. Hunter's final expression that "if it is necessary to use the lapse element for the salvation of societies, or to meet certain conditions of sickness and insurance plans, the calculation can only be safely undertaken by skilled actuaries."

Mr. R. P. HARDY said that as far as he knew the present was the first occasion upon which any systematic attempt had been made to show the effect upon the annual premiums that was due to the absorption of the reserves and the distribution of such relief over the long period involved in the whole term of life, and he thought Mr. Hunter was to be congratulated for breaking new ground and supplying the Institute with another subject for consideration and discussion. If the matter were to be one of mere argument, he could scarcely imagine, after the scathing and authoritative denunciation of Mr. George King, that anybody should want to satisfy his mind by further illustrations. If anyone did, he was bound to say that, so far as he could see, the author's demonstration was satisfactory, except in the small point that he doubted whether he was correct in adding together the rates of death and lapse. But he did not think it was fair to say—because the Institute of Actuaries was composed of fair people—that the paper stated the whole of the case; nor did he think that it said the last word that could, or probably would, be said upon the matter. To some extent it was an imperfect view simply to look at the question of the reserves. For instance, the author did not take into account the profit that would be made by the absorption of the gross premiums involved in the cessations, neither did he give sufficient effect to the undoubted fact that where the cessations were very heavy the rate of mortality was generally correspondingly lightened. He did not say that the rates of cessation and mortality were always connected, but in certain circumstances they frequently were, and it was an element which should not be ignored in considering the subject. Speaking fairly on the other side, he was equally bound to say that, making the most generous allowance for all such considerations, he had never come across a premium charged by one of those assessment concerns which could with any propriety be said to represent the value of a true life assurance, and that any man, therefore, who joined such an institution in the hope of making a provision for his family was suffering under a delusion, for which somebody would pay very dearly in the end. He had had some little experience in secessions with regard to friendly societies, and his friend, Mr. King, had had with him experience with respect to large service funds. He did not know what that gentleman would say, but he thought secession was the most dangerous subject for an actuary to touch, and that nobody should deal with it except those who were most experienced, and even they, if they were wise, would think twice before they did so. For an independent study of the general form secessions take, he ventured to suggest the following for the consideration of the students, which treated the rate of cessation as if it were a function of the rate of interest. In actual fact it was not so, because the rate was not a constant, but a diminishing quantity. Taking the Carlisle 3 per-cent table, and treating the D column as if it were an L column, subject to the combined forces of death and cessation—

SPECIMEN TABLE.—(*Carlisle 3 per-cent*).

x	D	Total Flux ($D_x - D_{x+1}$)	Deaths ($1 + i$) C_x	Secessions $l_{x+1}(e^x - e^{x+1})$
0	10,000	1785·437	1539·	246·437
1	8,214·563	882·109	662·135	219·974
2	7,332·451	675·714	476·011	199·703
3	6,656·740	...	...	...

ten thousand was the first D, the second D was 8,214·563; the total flux was 1,785·437—that is to say, the population had fallen roundly by 1,785 from the joint causes of death and cessation. If the flux were broken up into parts, 1,539 represented deaths, and the balance, namely, 246·437, were secessions, and so on, for the remaining ages. Speaking broadly, it came to this: that a 6 per-cent value was very nearly one at 3 per-cent interest with a 3 per-cent rate of cessation. It was therefore possible for the members to experimentise. They need not necessarily take 6 per-cent, but any other rate; or they could take one rate for the first portion of the Table, and others for the following ages. One of the most interesting portions of the paper was the account given by the author of the extent to which fraternal orders prevailed in America. The figures were a little startling, if people in England were not accustomed to dealing with figures on a somewhat large scale from America; but he thought the movement was a mere temporary phase which would pass away, as assessmentism had certainly done. It was due, he thought, to the constant social changes going on in America, which, contrasted with the comparative social stability in England, could be but imperfectly measured. These constantly moving forces induced the population to seek after some sort of insurance in the cheaper form, and as their need was but temporary, they were not very particular as to the quality obtained. He thought those were merely signs that the ferment was working. He thought it was impossible, even if it were desirable, and personally he had a prejudice in favour of liberty, to put down these experiments; but such papers as they had heard that evening, and especially such denunciation as they had had from Mr. King, would supply the more thoughtful leaders with some proper means of testing that class of scheme. They must not be in a hurry. They must be content with only gradual enlightenment. In England they were only just enlightened themselves. He could recollect the time of the loud lament when the old Northampton Table was abandoned. They only grew wise by degrees. They must not expect working men in America to arrive at wisdom at once; in fact, it seemed a particular case of the doctrine that “knowledge comes, but wisdom lingers.”

Mr. PAUL GIBSON said the author mentioned in the paper that several of the assessment societies were thinking of changing their basis from assessmentism to the lapse premium system, and through the paper the effect of an H^M lapse rate and a double H^M lapse rate was described. Although the question did not come strictly within

the scope of the paper, he thought it was natural to ask what was the approximate rate of lapse that one of the lapse premium companies would experience. He had considered the subject, but, of course, his conclusions were altogether theoretical; it would, however, be a pleasure to him if in any way his theory was corroborated by the experience of older and wiser members. If his theory was wrong, he would be very glad to learn the weak points. The lapse rate, it seemed to him, must be affected by three things—1. the unwillingness to pay premiums; 2, the inability to pay premiums; and 3, the inability to prevail on third parties to keep a contract up. There were other things which affected a lapse rate—the way in which business was forced, and the social position of the people who insured, &c., but these varied with each company and could not be treated generally. The conclusion he had arrived at was that the rate of lapse that a lapse premium company would experience would be very much lower than the rate of lapse experienced by an ordinary company—a company which gave surrender-values—and that it would be even slightly lower than the rate of lapse experienced by an assessment company with no surrender-values. The question of the unwillingness to pay premiums varied as the size of the premium in one way, but it mostly varied inversely as the loss incurred by not paying the premium. It would be seen at once that the rate of lapse would be very much greater in the ordinary company than in the lapse premium company, because the loss incurred in lapsing a policy in an ordinary company was small, especially where, as in America, large surrender-values were given. The inability to pay premiums was quite a relative term. Though the amount of premium came into question to a certain extent, it would not come into question very largely. The inability to pay a premium would be guided rather by the amount of loss incurred by not paying the premium than by the man's absolute pecuniary state. The lapse then from this cause would be greater in an ordinary company than in a lapse premium company. With regard to the third point—the inability to obtain third parties to keep a contract up—it might often pay third parties (in lapse premium companies)—especially in endowment insurances—to keep up the policy, whereas the surrender-value given by American companies was so large as to make it hardly worth while to keep up a policy even in endowment insurances. He thought that the rate of lapse in a lapse premium company was smaller even than in an assessment company, because the assessment company's premiums were so low that they often would tempt people to insure who could not continue to do so later on. He therefore advised the greatest caution in using the rate of lapse as a factor in the calculation of premiums or reserves.

Mr. GEORGE KING thought he would be voicing the general sentiment in expressing satisfaction at receiving a paper from across the Atlantic on a subject with which this country was not to any great extent practically familiar. It introduced the members to conditions that were very little known in England, and gave them matter for thought which could hardly be found on this side. The actuaries of insurance companies in the United Kingdom he did not think had ever been called upon to discuss the question of lapse rate

in connection with their premiums and valuations, and it was only those actuaries who had had experience outside in dealing with certain friendly societies and Service Funds who had had their attention drawn to any great extent to the subject. That led to the point he wished to bring out, namely, that the taking into account of the lapse rate in calculating premiums and estimating reserves was, under some circumstances, to his mind legitimate; while under other circumstances it led to a very serious danger. It seemed to him that the method was legitimate in Service Funds where the membership was compulsory on all those who entered the service; where it was compulsory throughout the whole duration of their service; and where lapsed membership was also compulsory when the officer left the service, except on pension. There the operation of the human will was practically left out, and there was something more solid to go upon than where a person might insure in a company, and retire at his pleasure, without reference to any fixed rules. In such a case as he had suggested, allowance could be made for withdrawals for a variety of causes, sometimes certain benefits accruing on withdrawal. There were very interesting problems that arose in connection with funds of that class. There were very complicated benefits, and at first sight it might seem almost impossible to value them, but by suitably applying the commutation method, very short formulas could be obtained, which gave the values required. He ventured to express the hope that their friend, Mr. R. P. Hardy, would see his way to give the Institute a paper on the subject. It was a subject with which he was thoroughly familiar, no one having had more experience of it than he. While he (Mr. King) said that in the case of Service Funds it was legitimate under certain circumstances to take into account the lapse rate, he repeated what Mr. Hardy had previously said about the necessity for infinite caution. The experience of such funds was that at the present time the rate of withdrawal was diminishing, and, speaking roughly, he imagined it would be found that the rate of withdrawal in a great railway fund was only about half now what it was about twenty years ago. Therefore, they must be very cautious in the lapse rate to be used, otherwise their estimates would be upset, and the error would be on the wrong side. It had been found that even a long experience of the fund itself was not always a sufficient guide, and that one must have a general knowledge of the course of business and the conditions of employment before purely technical formulas could be safely applied. Under certain circumstances, he did not think it was necessarily illegitimate to apply the lapse rate in calculating the premiums and in making valuations of certain collecting societies and friendly societies, where it was practically only burial money and sick pay which were at stake. He imagined the lapse rate in such cases was more uniform than it was with insurance companies, and was not affected so much by duration of membership or by variations in the kind of policies and in their magnitude. But there again it must be applied with the very greatest caution. In the Service Funds of which he had spoken the lapse rate was practically only a function of the age; it was not a function of the duration of service. There was only one class of

benefit, or one category of benefits, to which members contributed, and, therefore, there was no disturbance from other causes. But in the case of an ordinary insurance company the lapse rate became a function of the duration of the insurance, perhaps most of all. It was also a function of the age of the life; a function of the amount assured, and also a function of the class of policy. It therefore became an exceedingly complicated thing, and practically it was impossible to apply rules that would be safe. The author in his paper had taken the same lapse rate for term policies, whole-life policies, policies by limited payments, and endowment assurance policies, which was, of course, entirely erroneous. It was true the author only gave his figures as an illustration, and he did not suppose for a moment that he thought it would be proper to apply them in practice; in fact, the whole tendency of his paper was against the employment of the lapse rate at all, and in this he (Mr. King) entirely agreed.

MR. FREDERICK BELL thought that, if it were needed, Mr. Hunter's paper went far to show that there was no disposition on the part of the members of the Institute not to give to the claims of assessmentism full, fair, and unprejudiced consideration. It was not assessmentism fairly stated and prudently conducted that anyone would wish to pillory, but he ventured to think that assessmentism in this country had not been happy in its advocates. Mr. Hunter's example in the conversation on page 52 was a fair example of the exaggerated and false claims which were urged on its behalf. Having said so much in condemnation of the methods of assessmentism advocates, he ventured to think he should not be thought to be holding a brief for them if he pointed out that in the final reply of the imaginary person, whom he would call Mr. Answers, although at first sight it appeared false and misleading, it was not incapable of reconciliation with the statement of fact given on page 51 from Mr. King's lecture. Mr. King's words would bear repetition: "A company which trusts to its discontinuances in order to reduce its rates must, if it is to remain permanently solvent, make larger reserves than a company which charges the ordinary premium based upon mortality alone." There could be no misunderstanding. Mr. King's words were perfectly clear, but he did not say that the reply of the person, Mr. Answers, necessarily was in contradiction to Mr. King. The wording was that the reserve could be cut down if the lapse rate was taken into consideration. That might well be read "the contribution to reserve," and he did not think any of them would deny that in the smaller premium which the inclusion of the lapse element involved there was a smaller contribution to reserve provided. It was the fact that, taking lapses as they had been found to prevail into consideration, larger reserves were very soon found to be needed, but the contributories to those reserves were not only the policyholders whose policies existed, but those members who had lapsed their policies, and in leaving the company they left behind them their contribution, such as it was, to the reserves of the company. On the other hand, in what had been dubbed "old-line" companies, the discontinuants had taken with them in surrender-value practically the bulk of their contribution to reserve. Bearing that fact in mind, it would seem to those unacquainted with the subject, to that technically

uneducated person, the man in the street, that it only required a lot of lapses to raise the necessary reserve, and so to justify the "about half the usual rate" premiums, which had been so much in evidence in recent years. It was possible to imagine such a rate of lapse as would justify such premiums, but it was not necessary for him there to give any reasons why such a lapse rate was not to be depended upon. Mr. Hunter, in his paper, gave in exhibit B the premium rates which resulted from the inclusion of the discontinuant rates of the H^M Table, and also of twice those discontinuant rates. The whole-life premiums—which were the most important, because, as Mr. King pointed out, the rate of discontinuance was liable to vary very much in different classes of policies—showed a comparatively small difference from the rates resulting from the use of mortality alone. He thought they pointed to the exceeding improbability of such a lapse rate ever being experienced as would justify the rates which had been quoted by the assessment companies. There was a further, less scientific, and perhaps more practical, reason why such rates could never maintain a company, namely, that so huge a lapse rate as would be involved would mean ruin to the company. He thought the expenses would certainly crush any company subject to such an enormous lapse rate. If Mr. Hunter had been present he would very much like to have asked him one question—why he took for the foundation of some of his tables double the H^M discontinuant rate. He had had before him for some little time the task of endeavouring to ascertain from very imperfect materials the rate of lapse which had been experienced in an assessment company. He had not access to its records, and therefore his sole basis was a very careful examination of the valuation and annual returns. The impression he obtained from that examination was twofold: firstly, that the lapse rate at the commencement of the insurance was very high, much higher than twice the H^M discontinuance rate; but secondly, that it rapidly approached to it as the policies grew older. Bearing that in mind, he had the curiosity to calculate the rate including lapses with different incidence to those employed by Mr. Hunter. He took as his discontinuant rate twice the H^M rate for the first year of insurance, multiplying the discontinuant rate by 1.9 for the second year, 1.8 for the third year, and so on. The result was that the premiums were about half-way between the author's two rates, and the reserve, of course, followed. He ventured to think from that result that it was borne out that no assessment company could live on "half the usual rates", notwithstanding the fact that its number of lapses in the early years was very high. He did not think that that would permanently save the situation. That was the main point; the larger lapse rate at first, though it would, no doubt, buoy up the hopes of the management of an assessment company, would be but a broken reed to lean upon, and in a comparatively short time they would find themselves subject to very much the lapse rate experienced by other companies, and then it would be found that their reserves were utterly insufficient.

Mr. T. G. ACKLAND said the idea suggested by Mr. Hardy of taking the commutation D_x column as representing the double operation of decrement from death, and from any other cause, such as withdrawal, appeared to him to be a very ingenious method, and one

that was certainly new to him. The operation of the "flux" from death, as set out in the third column, and of the cessations as set out in the fourth column, were shown with remarkable clearness and lucidity. The subject of withdrawal, as Mr. Hardy had said, had not been dealt with in the columns of the *Journal* in at all a full or satisfactory manner, and one could not help hoping that the time would soon arrive when some writer of eminence and skill would deal with the subject somewhat more fully than had been the case in the past. He had the opportunity, in connection with an association which he valued some years ago, to lay before the Institute some imperfect results as to the operation of a double rate of death and withdrawal. One thing that somewhat puzzled him, in his partial study of what was set out in Mr. Hunter's paper, was how to prove the statement which Mr. King had made, as quoted on the first page of the paper, that where the element of withdrawal was introduced the reserves were invariably increased. That appeared to be stated without qualification, and Mr. King stated that it could be mathematically proved. No doubt this was true, generally speaking; but it appeared to be shown by Mr. Hunter, and also in the paper he himself had the honour to submit some years ago to the Institute, that where the element of withdrawal was introduced the reserves were in some cases diminished. He thought in the case of the association valued by him, the reserves were diminished throughout the first ten years, and it was not until a duration of fifteen years had elapsed that the reserves began to be increased, as compared with what might be called the normal reserves where the element of cessation was not introduced. He thought, moreover, the question was complicated by the fact that in practice they would very seldom use a net premium allowing for cessations. The premium which was more commonly used, so far as his limited experience of such societies went, where a withdrawal rate was introduced, was largely governed by the office premium or tariff rate which was actually charged by the company. They did not always feel at liberty to use the net premium allowing for withdrawals, but they had to be governed by the fact that a certain percentage had to be thrown off the tariff premium for expenses. That of course materially affected the question of reserves, and would no doubt produce different results as regards their relative increase or decrease. Reverting for the moment to the question of the method followed in setting out a table of double decrement, he thought it would be found with Mr. Hardy's method assumed, that the deaths were equally distributed throughout the year, but that the cessations fell at the end of the year. That would seem to be a quite reasonable assumption. Mr. Hunter made a rather different assumption in his method by adding together (erroneously as he ventured to think) the rates of mortality and withdrawal. That could only be legitimately done, as he judged, where the deaths and the withdrawals were assumed both to have their full incidence at a certain moment in the year, identically at the same instant. The effect of Mr. Hunter's assumption was that the whole of the cases exposed to risk for the year were exposed both to death and withdrawal. It was perfectly clear, taking Mr. Hunter's figure of 10,000, that some of those 10,000 were dying through the year, and that the numbers exposed to withdrawal were thus reduced;

and it was equally clear that as some of the 10,000 were withdrawn, the numbers exposed to the risk of mortality were similarly reduced. Dr. Sprague had shown in a paper in the *Journal* (xxii, 77) dealing with the question of marriage and mortality (which was quite analogous to the present subject), how the matter could be dealt with in a scientific manner, by deducting from the sum of the two rates for withdrawal and mortality, approximately the product of the two rates. They had the one rate, representing the rate of mortality, and also the other, the rate of withdrawal. Those two were added together, but the product of the two rates was deducted from the sum. That, he ventured to think, was a more correct way of arriving at a combined table of mortality and withdrawal. Mr. Chatham, in a paper contributed to the *Journal* (xxviii, 384), had illustrated the method in practical detail. A table would thus be obtained, similar in its general lines to Mr. Hardy's ingenious table, but in which the figures were slightly different, because they assumed that the deaths and the secessions were both equally spread throughout the year.

Mr. JOHN HOLLIDAY wished to refer to one point in connection with the Fraternal Orders of America and the friendly societies of England. It was taken for granted in the paper that they were analogous. In some respects they were, but he thought he was correct in saying that friendly societies involved the working classes only. That was not the case in America. America was essentially a country of Orders. So far from those Orders dealing only with the working classes, if one inspected the State returns, it would be found that a great many Orders dealt with a large number of the middle classes. In one large Fraternal Order the average amount insured was \$4,000 (about £800), a very different amount from the friendly societies in England. Mr. Hardy took the view that the Fraternal Orders, with their assessment insurance, were more or less a temporary phenomenon which would disappear. That, however, did not appear to be Mr. Hunter's view. The intellectual status of the Fraternal Order was of a character which did not seem to point to extinction. The members of such orders possessed an intelligence and vigorous life which was not found in the friendly societies in this country. As somebody had said, America had a population of seventy millions, and it was out of the question that everybody should follow the same line of insurance. Assessmentism in America was a very burning question, whereas in England it seemed to have died a natural death. That, he took it, was the real significance of the author's paper. He wished to bring the question into a cooler atmosphere and have the opinion of the Institute, a body which carried so great an authority all over the world, expressed upon it. Mr. Hunter had put the case very fairly, because he had not referred to the co-operative societies at all, but only dealt with what corresponded to our friendly societies. The question to be decided was what was to be done with the Fraternal Orders? If they were not going to die a natural death, then Mr. Hunter's appeal remained—was the profession going to help them, or was their attitude to be hands off and let them go to financial ruin? He understood Mr. Hardy to think the question was too dangerous to touch. No doubt that represented pretty fairly the invariable view of the

members, but the author wished to put the question afresh, and he thought he had some support in America behind him.

Mr. H. W. MANLY agreed with the previous speakers that the paper was one which was needed, as introducing for their consideration a class of so-called insurance business which had not found favour here, but which was practised to a very large extent in America. Mr. Holliday seemed somewhat to regret the position that those companies might be found in eventually, and hoped something might be done to avert the catastrophe, but he was afraid they could not do more than educate the public up to what was right. He stated some years ago, when writing upon assessmentism, that the Americans had not been able to produce a fraternal society which had lasted for thirty years. One, the "Knights of Honor," or a name something like that, had come very close to it, but before the thirty years were up it had to go into voluntary liquidation—or rather, as there was precious little to liquidate—it disappeared. He wished to emphasize what had already been said by Mr. Hardy, Mr. King, and Mr. Ackland, that the very greatest care and caution must be taken before they introduced the lapse element into their calculations. It was no use applying the lapse rate, in one class of society, or even one class of policy, to another class. That, he thought, was very aptly illustrated in the case of the tontine policies. Extravagant estimates were originally made of the profits which would accrue to the survivors of the tontine classes from calculations based upon the lapse rate amongst the ordinary policies previously issued by American companies. It would be remembered that the excuse made by the companies when the actual results did not correspond with the estimates, in fact were very much lower, was that the lapse rate had not been so great as had been anticipated. Twenty, twenty-five, or thirty years ago, life insurance was treated by the people in America as of the nature of a temporary cover. They insured their lives for two, three, seven, or ten years in order to cover a period when they were engaged in some speculative operations or to provide for the continuance of some works that they were undertaking. If they were successful, they surrendered or dropped the insurances; if unsuccessful, the policies were lapsed through inability to keep them up. But when the public were invited to go in for a tontine insurance, where it was held out that the scheme would prove a magnificent investment, a different class of people entered, and they did not lapse their policies so readily. He thought that an observant actuary would have known that they were appealing to a different class of people and that the lapse rate would be different. One point had not been referred to by previous speakers, and perhaps it only incidentally arose out of the paper. The last question and answer in the imaginary conversation given on page 53 was: "Q.—Would the reserve or accumulations be reduced if the lapse element were used? A.—Undoubtedly. As the expectation of life at age 35 is about 31 years and the average life of a policy is only about 10 or 12 years, it naturally follows that the accumulation or reserve can be cut down to a very large extent." This statement about the average life of a policy had got about very largely. It was used frequently in America to justify the small rates which had been charged for insurance by assessment companies and

others. As an illustration of the attempted use of such statement, he would mention a little incident which occurred in the Law Courts not long ago. He thought it a pity that that case was not fully reported in the papers. If it had been, the public might have received some useful instruction. He (Mr. Manly) happened to have been in the witness box the whole of one afternoon; and the next morning a very clever young Queen's Counsel put him under cross-examination. After stating that he and his clients had been up the previous night until 12 o'clock to find some way of rebutting his evidence, the Q.C. began: "Mr. Manly, you know the average life of a policy has been calculated, has it not?" I said, "No, I am not aware of it." Then he said, "But the average life of a policy has been calculated exactly to the fraction of a year?" I said I was not aware that anybody had calculated it. Then he said, "But you know that Mr. Teece has written upon the subject, and he is a very excellent actuary." I said, "Certainly, he is a very excellent actuary." He said, "He has written upon the subject." I said, "Indeed, I am not aware of it: I have not seen it." "Oh," he said, "here is his book," and he handed up to me a recent report upon the investigation of the Australian Mutual Provident. I said, "Yes, I have seen that." Then he said, "It is there stated that the average life of a policy in the H^M Tables was so much." I said, "Yes, excuse me, that is the average time that those policies which were under observation had been in existence. A large number of them were still in existence. You cannot say that you have calculated the life of a policy while it still exists. It would be exactly like supposing I were to take an observation of the eminent Queen's Counsel in this Court—and there were a great many there—and found out the number of years that each has been Queen's Counsel, and then took the average, and stated that as the life of a Queen's Counsel, I do not think that you would agree with that." He said, "We will leave that for the present, and go to the next subject." They had found that in the Institute of Actuaries' Experience the average number of years during which the lives had been under observation was nine and three-quarter years, and had concluded that that represented the average life of a policy. He had risen more with the object of exposing that fallacy, which seemed to grow and grow, than of criticizing the paper. He had seen the statement asserted as a fact over and over again in the American papers, and occasionally in English papers; and if these assessment and fraternal societies based their calculations on the assumption that a policy on the average did not last longer than ten years, one could not be surprised that after about twenty years they got into all manner of difficulties.

Mr. STANLEY DAY, in summing up the discussion, said he was sorry the President had not chosen someone who was better versed in the American insurance systems than he was, as he was only familiar with those practised by offices represented in England. Of those offices he found the great majority had no leaning towards any system of "cheap" insurance; in fact, they always liked to secure very large premiums, and generally got them. Turning to the paper, he saw that Mr. Hunter referred to a discontinuance rate of, approximately, 30 per-cent. He had looked at the Institute

Experience of 1863, and he found there that it roughly worked out at just under 30 per-cent. Turning to the new experience, and looking at the new entries since 1863 under the whole-life table, the rate of withdrawal there came to $31\frac{1}{2}$ per-cent—apparently a slight increase. Then, looking to the endowment rate of withdrawal in the same experience, the rate for all terms of endowment was well under 20 per-cent—a very marked difference. What the rate would be for 10-year endowments of course they could not say, but it must be very light indeed. He thought they must disregard all the “fancy” tables given in Mr. Hunter’s paper and keep solely to the whole-life rates of the premium and reserves. If they looked at his exhibit of the reduction of premiums consequent on the lapse rate being taken into account, it would be found that for a lapse rate of 30 per-cent a reduction in the premium of 4 per-cent to 5 per-cent was obtained. When a 60 per-cent rate was taken the reduction was practically doubled—from 8 per-cent to 10 per-cent. There was a curious confirmation of the first rate available. If one turned to the Blue Book of last year it would be seen that the amount of the surrender-values paid away by British companies was one million, approximately, and that the total of premiums received for the year was 20 millions, approximately; so that, looking at it rather roughly, one might say that if no surrender-values had been paid they could have afforded to reduce premiums by approximately 5 per-cent, which was exactly what Mr. Hunter arrived at. He did not think he need go through all the interesting arguments given that evening. He did not think he ought to presume to criticize Mr. Hardy or Mr. King. He thought it would be an excellent thing if Mr. Hardy gave them the paper Mr. King suggested on rates affected by secession, as nobody knew more about it than Mr. Hardy. A very interesting suggestion had emanated from Mr. Trouncer—that the premiums, if reduced at all, should be reduced for 10 years only. Probably that might be workable. He thought the general feeling was that none of those rates of secession were really satisfactory as affecting a life office. When one thought that a general withdrawal rate (which, of course, was equivalent to a lapse rate in such cases) of 30 per-cent only meant a reduction in the premium of 5 per-cent, was it worth it? He thought not. Most of these fraternal orders, as he understood, had a very high rate of expenditure, considerably over 25 per-cent, and he thought it would be much more satisfactory to save 5 per-cent in the working expenses, which could probably be done by keeping the policies on the books a little longer.

We have pleasure in giving the following remarks by Mr. Hunter on the discussion which took place when his paper was read, he having been unavoidably absent from the meeting.
—Ed. *J.I.A.*

The extended discussion and the friendly remarks on my paper are exceedingly gratifying to me. I am frank to confess that the interest

taken in my effort has been far greater than I had any reason to expect.

Mr. Trouncer and other speakers drew attention to the fact that the same percentage of lapse has been taken for all forms of policies. This was done advisedly in order to make the exhibits as clear as possible, and in order that general deductions might be more easily established. Judging from the result of several investigations, I am convinced that the relative size of the premium has a great deal to do with the percentage of lapse. In one case the lapse rate for all ages on the 10-Year Endowment plan was found to be approximately one-half of the rate under the Ordinary Life plan. The 10, 15, and 20-Payment, also the 15 and 20-Year Endowment plans, had percentages of lapse varying between the Ordinary Life and 10-Year Endowment, largely in accordance with the amount of the annual premiums under these forms.

In Mr. Hardy's remarks attention was drawn to my not giving "sufficient effect to the undoubted fact that where the cessations were very heavy the rate of mortality was generally correspondingly light." It appears to me that the rate of mortality does not solely depend on the rate of cessation, but upon other causes, such as the management of the company. If a heavy lapse rate is caused in any year by natural causes, such as business depression, it is doubtful if the rate of cessation has a marked effect upon the rate of mortality. On the other hand, if a heavy lapse rate be due to lack of confidence in the management, the mortality will be heavy. Want of confidence in the management, resulting in most cases from the publication of various charges in the insurance press, causes the members in good health to seek other insurance, leaving the remainder of the lives in impaired condition. Two instances of this have come under my notice. In both cases the rate of mortality for two or three years after the disturbance resulted in mortalities ranging from 125 per-cent to 150 per-cent of the H^M Table, whereas the ratio prior to that time had been considerably below the H^M standard.

Mr. Hardy's suggestion of treating the rate of cessation "as if it were a function of the rate of interest" is exceedingly interesting. The late Dr. Wm. D. Whiting had a theory that the lapse element could be treated by computing the premiums at a higher rate of interest, say 2 per-cent greater than was necessary in the case of premiums without lapse. He did not, however, fall into the error of assuming that the reserves could be treated in the same way. It may be interesting to state that he also had a theory that under-average business could be treated in a similar way by taking the rate of interest from 1 to $1\frac{1}{2}$ per-cent below that used by the company for its standard business.

Mr. Paul Gibson's conclusions that the rate of lapse which a "lapse premium company would experience would be very much lower than the rate of lapse experienced by an ordinary company" may be logically correct, but is not so practically, judging from two or three experiences which it has been my lot to see. The lapse factor, especially in America, depends largely on conditions of competition and methods of management. In the early years of a Fraternal Order, when the rate of mortality is low, the rate of lapse

is very moderate; but the converse holds good when the mortality commences to reach the maximum. Again, a company operating by means of the lapse element may be, and often is, an Ishmaelite. It is attacked in competition by the agents of "Old Line" companies on the one hand, and by the managers of the Fraternal Orders on the other, with the result that the rate of cessation is apt to be high.

I desire to thank Mr. Bell for drawing attention to an omission. It was my intention to state more explicitly that the contributions from each member to reserve are smaller with lapse than without it, but that the aggregate reserve, divided among the remaining members, is usually greater under the former than under the latter. It is highly probable that the fact of a smaller contribution per member to reserve has misled the assessment advocates into thinking that the total reserve would also be less. Mr. Bell asks the question—Why did I take double the H^M discontinuant rate? It was merely done in order to show the effect of the lapse rate in the easiest manner possible. It seemed logical to take "No Lapse," "Normal Lapse," and "Double Lapse Rate." As already stated, it appears that the lapse rate varies considerably with different companies, and is probably as much dependent upon agency methods and the general repute of the company as upon commercial prosperity or depression of the country. In comparisons of lapse rate, therefore, one company should not be taken with another, but rather one cycle with the succeeding cycle of the same company.

It is pointed out by Mr. Ackland that it is erroneous to add together the rates of mortality and withdrawal. That I am perfectly willing to concede. The error is so small, however, that it cannot in any way affect the general conclusions, and the saving in labour is my excuse for using the method pursued in the various exhibits.

The problem of putting the Fraternal Orders on a sound basis is a very important one. To many actuaries in this country it seems almost an impossibility. It may be that the managers of the Fraternal Orders will work out their own salvation in their own way. As pointed out by Mr. Holliday, the class of people in Friendly Societies is quite different from that in the Fraternal Orders—the latter being of a higher social standing than the former. As the Fraternal Orders have about £1,200,000,000 (sterling) insurance in force, their value in the political economy of the United States is large.

THE INSTITUTE OF ACTUARIES.

VALUATIONS OF REVERSIONS FOR ESTATE DUTY UNDER "THE FINANCE ACT, 1894."

In advising as to the value of Reversions for Estate Duty under "The Finance Act, 1894", actuaries have not infrequently found of late that their valuations have been called in question by the Estate Duty Department; the friction and delay caused by prolonged correspondence were distasteful alike to the actuaries and their

clients, and it was felt that the time had arrived for the profession to take steps to place matters upon a more satisfactory footing.

The question was brought before the Actuaries' Club, who, after careful discussion, determined to submit it to the Council of the Institute of Actuaries.

At the Council of 13 November 1900, a letter from the Actuaries' Club, on the subject of Valuations for Probate, was read. It was resolved: That the Council arrange for an interview with the authorities on the subject of actuarial valuations under "The Finance Act, 1894", and the following members were nominated as a committee to form the deputation:—Mr. Higham, President, and Messrs. Manly, Burridge, and Woods.

The Committee were of opinion that an interchange of views by means of personal interview between themselves and the officials of the Estate Duty Department, would be the most likely means of removing the misunderstanding which had evidently arisen. An interview, which was readily accorded, took place between the Committee and Mr. Wallace, the Secretary of the Estate Duty Office, on 3 December last.

Mr. Wallace having courteously intimated that he should be glad to be favoured with the fullest information, the President stated at length the difficulties involved in ascertaining the market values of Reversions, alluded to causes which regulate frequent changes in such market values, and showed that it was possible only for practising actuaries having cognizance of the cause and effect of such changes, to form a correct estimate of the values of Reversions.

The general drift of the President's remarks, and of those of the other members of the Committee, was to the effect that the sole object of the actuaries was to assess the values impartially; and they proceeded to point out that the bases and methods of valuation could not profitably be stated in actuarial opinions, nor discussed with gentlemen who lacked the professional training.

A sympathetic interchange of views occurred, and full answers were given to questions put by Mr. Wallace, and it was agreed that, while a proper deduction might be made for costs of ultimate realization, no such allowance was appropriate for immediate costs, as might be the case in a valuation for purchase.

The Committee felt that the purpose of the interview had been effected in a manner agreeable to both sides, and were confirmed in this view by the subsequent correspondence, which is appended hereto:—

[*Copy.*]

ESTATE DUTY OFFICE,

SOMERSET HOUSE, W.C.

7 December 1900.

SIR,—I have submitted to the Board of Inland Revenue the notes of the interview which took place on the 3rd instant, when I discussed with you and the other members of the Deputation from the Institute of Actuaries, the question of actuarial valuations of reversionary property as affecting claims for Death Duties.

The Board now authorize me to state that, as a general rule, they

are willing to accept without question an actuarial valuation in cases where the property included in such valuation does not exceed £2,000 in value.

In the more important cases the question of value will in future be considered in the light of the information furnished upon the subject by the Deputation, rather than by reference to the Tables annexed to "The Succession Duty Act, 1853." The Board, however, must reserve to themselves the right to question any valuation, whether above or below £2,000, which they may consider not to be satisfactory.

The Board trust that this arrangement will go far to meet the views of your profession. For the present they do not think it advisable to go further.

But they feel that in all cases in which doubts may arise, they may rely upon the co-operation of the Members of your Institute in any enquiries which they, through their officers, may have to make, to test the accuracy of the valuations placed before them.

If occasion should arise in the future for any further conference on the subject, the Board would gladly meet you again, and I am to thank you for the information which you have already placed before them.

I am, SIR,

Your obedient Servant,

(Signed) ROBT. J. WALLACE,
Secretary.

C. D. HIGHAM, Esq.

[*Copy.*]

INSTITUTE OF ACTUARIES,

STAPLE INN HALL,

HOLBORN, W.C.

11 December 1900.

SIR,—I have read to the Council of the Institute of Actuaries your letter of the 7th inst., and would beg to assure you of their appreciation of the kindly consideration given to their views by the Board of Inland Revenue.

Actuaries (that is to say, Fellows of this Institute or of the Faculty of Actuaries in Scotland) desire to impartially assist the Department in their valuations of the character in question, and they recognize that the Board has a duty to the public; at the same time they would ask the Board to recollect that their methods cannot profitably be discussed unless there has been the technical training on both sides.

I am, SIR,

Your obedient Servant,

(Signed) C. D. HIGHAM,
President.

ROBERT J. WALLACE, Esq.,

Secretary,

Estate Duty Department, Somerset House.

[Copy.]

INSTITUTE OF ACTUARIES,

STAPLE INN HALL,

HOLBORN, W.C.

31 December 1900.

MY DEAR SIR,—I have been informed of the Department's courteous concession to certain actuarial views expressed in a case recently before it, and beg to assure you of our appreciation of your personal intervention, as the result, doubtless, of the pleasant interchange of opinions which lately took place.

Possibly the enclosed* may be of service to you.

Yours very faithfully,

(Signed) C. D. HIGHAM.

ROBERT J. WALLACE, Esq.,

Secretary,

Estate Duty Department.

[Copy.]

ESTATE DUTY DEPARTMENT,

SOMERSET HOUSE, W.C.

1 January 1901.

MY DEAR SIR,—I am much obliged to you for your courteous letter of the 31st ult., and for the List of Members which you were kind enough to enclose. It will be of service to me. I don't anticipate that much difficulty will arise in future between this Department and the Members of your Institute. There may be some few cases in which we may have to seek for further information before passing the valuation, but I am sure that any reasonable enquiries will be cheerfully answered by those whom you represent.

Yours very faithfully,

(Signed) ROBT. J. WALLACE.

C. D. HIGHAM, Esq.,

*President of the Institute of
Actuaries, &c., &c.*

EXTRACTS FROM "FINANCE ACT, 1894."

Section 7, sub-section 5.

The principal value of any property shall be estimated to be the price which, in the opinion of the commissioners, such property would fetch if sold in the open market at the time of the death of the deceased.

* *List of Members of the Institute.*

Section 7, sub-section 6.

Where an estate includes an interest in expectancy, Estate Duty in respect of that interest shall be paid, at the option of the person accountable for the duty, either with the duty in respect of the rest of the estate or when the interest falls into possession, and if the duty is not paid with the Estate Duty in respect of the rest of the estate, then:—

- (a) for the purpose of determining the rate of Estate Duty in respect of the rest of the estate, the value of the interest shall be its value at the date of the death of the deceased; and
- (b) the rate of Estate Duty in respect of the interest when it falls into possession shall be calculated according to its value when it falls into possession, together with the value of the rest of the estate as previously ascertained.

Section 7, sub-section 8.

Subject to the provisions of this Act, the value of any property for the purpose of Estate Duty shall be ascertained by the commissioners in such manner and by such means as they think fit.

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THE PATRIOTIC FUND.

Our readers will be aware, from speeches in Parliament and letters in the newspapers, that no little dissatisfaction has been expressed from time to time with the methods of the Royal Commissioners of the Patriotic Fund; and particularly have the amounts which they have thought it desirable to reserve for future liabilities been called in question. The recent placing at their disposal of a sum of about £400,000, collected for the benefit of the widows, orphans, and other dependents of the officers and men of our forces who might lose their lives in the operations in South Africa, has incited further criticism, while Mr. Finlaison's death in September last deprived the Commissioners of their actuarial adviser.

In these circumstances, it was obvious that the Commissioners would need actuarial assistance such as would be received without question not only by those who had previously raised objections, but also by the multitudes interested in the funds, whether as subscribers or possible beneficiaries. Happily there are many whose attainments and position would be recognized without dispute; and yet it was felt that, better than any individual opinion, if the President and Council of the Institute, as representative of the profession in this country, were, for the sake of patriotism, in their joint capacity to advise the Commissioners, no reasonable person could then deny that the Commissioners might with the utmost confidence base their action on an opinion so obtained. It was felt, too, that the Institute ought not to be backward if the country had need of its services; and that the Members, who have doubtless all, according to their measure, already supported one or other of the funds that have been raised,

would be glad that skill and labour should also, when wanted, be at once freely offered on the profession's behalf.

A new departure was therefore taken, in that the President (Mr. Higham) placed himself informally in communication with the authorities, and made the suggestion; and it was accepted without hesitation, as being certain to ensure the absolute confidence of the public. The following letter was then addressed to the Secretary of the Commission, and an extract from his reply is also appended, for the whole letter was necessarily lengthy, as it went on to give details as to various funds, and schedules of statistics accompanied it. It need only further be added that those concerned are now hard at work in preparing for the necessary valuations.

THE INSTITUTE OF ACTUARIES,

STAPLE INN HALL,

HOLBORN, W.C.

15 February 1901.

SIR,—In recent public speeches and correspondence as to making provision for the relatives of those who have fallen in South Africa, there would seem to have been some difference of opinion as to the amounts the Royal Commissioners of the Patriotic Fund think it desirable to keep in hand for their future requirements.

However great may be the attainments of the actuary they consult, it is probable that any individual opinion will undergo criticism in view of the large numbers that are deeply interested in the subject, and I beg you, therefore, to ascertain whether it would be agreeable to the Commissioners that the President and Council of the Institute of Actuaries should, for the present—of course, in an honorary capacity—furnish them with any necessary actuarial advice. I am emboldened to make this proposition by the death, not long since, of Mr. Finlaison—himself at one time President of the Institute—who had previously acted in the matter.

The Commissioners, if they approve of the suggestion, would doubtless cause to be prepared the schedules of the facts customarily required when an actuary makes a valuation, and the united opinion, to which reference has been made, could then be given. Though I am bound to point out that the Council cannot bind its successors, I have the gratification of assuring you that those now serving on it would welcome the opportunity of contributing something of any skill they may possess in the service of their King and Country.

I am, SIR,

Your obedient Servant,

(Signed)

C. D. HIGHAM,

President.

COL. J. S. YOUNG,

Secretary,

*Royal Commission of the Patriotic Fund,
53 Charing Cross, S.W.*

[No. 460—1901.]

ROYAL COMMISSION OF THE PATRIOTIC FUND,
53 CHARING CROSS, LONDON, S.W.

21 *February* 1901.

SIR,—I am directed to acknowledge receipt of your letter of 15th instant, conveying the proposition that, if agreeable to the Patriotic Fund Commissioners, the President and Council of the Institute of Actuaries should for the present, in an honorary capacity, furnish the Commissioners with any necessary actuarial advice they may desire.

The Commissioners most highly appreciate the public spirit, as expressed in the concluding sentence of your letter, which has prompted you and the Council of your Institute to make this proposition as a contribution in the service of their King and Country of the skill you and they possess in actuarial matters.

The Commissioners most cordially and gratefully accept the proposition so generously made.

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In respect of all these funds I am desired to submit to you the usual statistical information as at 31 December 1900, as furnished to the late Mr. Finlaison, and to beg the favour of a report of your valuation of the assets and liabilities as they stood at that date.

I am, however, to state that any other information you may require shall be most readily afforded.

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I am, SIR,

Your obedient Servant,

(Signed) J. S. YOUNG, *Colonel,*
Secretary.

SYLLABUS OF MESSENGER PRIZES, 1901.

THE Council of the Institute of Actuaries have resolved to offer Two Prizes, of the value of *Forty Guineas* and *Twenty Guineas* respectively, for the best two Essays on the following subject, namely:

“The Reserves and Surrender Values in respect of Endowment Assurances, according to the different methods and bases of valuation in common use.”

While Competitors will have perfect freedom in their treatment of the subject, the necessary actuarial formulas and practical methods should be investigated, and it is considered desirable that the following (amongst other) points should be discussed:

1. The relative amount of Endowment Assurances according to age at maturity, age at entry and duration, in existence at different periods in an average progressive

company. Intervals of five years would be considered sufficient.

2. The different methods of allotting surplus, and the effect on the bonus of change in method of distribution or basis of valuation.
3. Surrender Values, from the point of view of the Company (whether Mutual or Proprietary), the Policyholder, and the Investor; and whether the condition of health of the life assured, or the probable future bonuses, or both, should be taken into consideration in quoting them.
4. The amount of Fully Paid-up Policy, either with or without profits, to be granted in lieu of the Policy surrendered.
5. The basis on which Policies should be converted from Whole-Life to Endowment Assurances, and *vice versa*.

CONDITIONS OF THE COMPETITION.

1. Reference must not be made to individual Companies by name.
2. The Essays must be sent to the Honorary Secretaries of the Institute of Actuaries, at Staple Inn Hall, not later than 31 March 1902.
3. The Adjudicators shall be the President and Vice-Presidents of the Institute at that date.
4. Each Competitor must send in his name, under seal, with a Motto corresponding to one to be prefixed to his Essay. Such Motto and Essay must not be in the handwriting of the Competitor, and should be, where practicable, type-written.
5. Successful Essays shall become the property of the Institute.
6. Unsuccessful Essays will be returned, on application at the Institute, with the corresponding envelopes unopened.
7. No Prize will be awarded except to an Essay the Adjudicators consider worthy of the distinction, and a prize will be divided if they so recommend.
8. The Competition shall be open to all members of the Institute, except members of the Council.

ERNEST WOODS, }
F. SCHOOLING, } *Hon. Secs.*

STAPLE INN HALL, HOLBORN, W.C.

March, 1901.

JOURNAL

OF THE

INSTITUTE OF ACTUARIES.

The Increase of Cancer. By RICHARD TEECE, F.I.A., F.F.A.,
*Manager and Actuary of the Australian Mutual Provident
Society, Sydney.*

[Read before the Institute, 25 February 1901.]

IN applying this title to the following remarks, I am quite aware of the fact that a number of authorities, whose opinion is entitled to the highest respect, will at once pronounce it a misnomer, for the reason that, while all statistical returns disclose an increase in the rate of mortality from cancer, such increase is held to be only apparent, and is not real, but is due to improved methods of diagnosis. This view was propounded and ably advocated in a paper by Mr. Geo. King, F.I.A., and Dr. Newsholme, printed in the *Proceedings of the Royal Society of London*, vol. liv, 1893. The position taken up in that paper was that, as cancer is a disease of middle life and old age, no satisfactory conclusion could be reached, except by a distribution of the living and the recorded deaths from cancer into the various age periods. The gentlemen named proceeded with their investigation on this basis, and arrived at the conclusion that no actual increase in the death rate from cancer had taken place, but that the apparent increase was due to improved methods of diagnosis and to erroneous methods of tabulating the data. In a paper in *The Practitioner* for April 1899, Dr. Newsholme repeats his conviction that the statistics "do not justify the conclusion

“that an increase in cancer mortality has occurred within recent “years.” The object of the following inquiry is to endeavour to ascertain whether this position can be maintained in the light of the facts now at our disposal. In the tables which follow I have employed the figures given by Mr. King and Dr. Newsholme as far as they serve, bringing them as nearly up to date as the means at my command will admit. Table I gives the number of deaths from cancer in England and Wales during the years 1851 to 1897 (inclusive) among “males, females and persons.” With two or three trifling exceptions, the numbers show a steadily progressive increase from beginning to end. These figures are in themselves, of course, quite inconclusive. The population has been increasing in number and average age; the increase in the general vitality of the nation has enabled a larger number of people to reach old age, at which cancer is of more frequent occurrence, and admittedly there has been an improvement in diagnosis between the beginning and end of the period under review. Comparing two quinquennial periods at different times, we have the following exhibit :

Average Annual Mortality per Million.

		Males	Females
1883-7	. .	415·4	720·6
1893-7	. .	589·0	893·6
Increase	. .	41·8 %	24·0 %

Table II shows the population and cancer deaths in England and Wales, arranged according to age periods; and Table III shows the death rates per million deduced from the figures in Table II. The first point which attracts attention is the extraordinary increase in the death rates from age 45 upwards. The next is that, with exceptions which may be disregarded, the rates have constantly and rapidly increased both for males and females from the beginning to the end of the period under review. Improved methods of diagnosis may, and probably do, account for some portion of the increase between 1860-66 and 1881-87; but can it be seriously contended that it has been similarly effective for the period between 1881-87 and 1895-97? From the tables just quoted we find that the deaths per million have increased between the periods 1881-87 and 1895-97 as under :

		Ages 25-45	Ages above 45
Males . . .	from	167·6 to 236·2	1,942·4 to 2,970·6
Females . . .	„	463·8 „ 519·4	2,990·0 „ 3,923·4

I have not been able to obtain later figures for Scotland and Ireland than those quoted by Mr. King and Dr. Newsholme to enable me to complete the tables in the form given by these gentlemen, and it is not necessary to repeat their figures here; but it may not be out of place to reproduce the rates for those countries supplied by Dr. J. F. Payne in the *Lancet* for 16 September, 1899. These are as follows:

Annual Death Rate per Million, 1883-97—Scotland.

	Persons	Males	Females
1883	540	430	640
1884	550	430	670
1885	560	420	690
1886	590	430	740
1887	600	460	730
1888	610	470	750
1889	670	520	810
1890	610	470	740
1891	680	520	820
1892	670	530	810
1893	690	550	830
1894	720	520	900
1895	730	560	880
1896	730	590	840
1897	770	580	940

Ireland, 1877-97.

1877-91 (average)	.	.	442
1892-96	„	.	504
1897	.	.	579

In the paper from which these figures are extracted Dr. Payne deals with the treatment of the Frankfort statistics by Mr. King and Dr. Newsholme, and his criticisms are deserving of careful attention; but as they are accessible to all inquirers I need not reproduce them here.

In Table IV, I have carried on the comparison of Mr. King and Dr. Newsholme of the deaths in England and Wales and among the lives assured in the Scottish Widows' Fund up to the latest date for which returns are available. It will be seen that in whatever light this table is regarded the same remarkable and persistent increase in the death rate is observable.

In Table V, I have also carried on the figures of Mr. King and Dr. Newsholme as far as practicable, with the same result.

Mr. King and Dr. Newsholme attempt to discredit the apparent teaching of these statistics by an investigation into the cancer death rate in Frankfort, when due effect is given to the influence of age distribution. This aspect of the case is dealt with by Dr. Payne in the paper in the *Lancet* to which I have already referred. If all that is claimed for the Frankfort statistics be admitted, can it be fairly contended that they outweigh the teaching of the comparisons already given?

The Practitioner for April, 1899, is wholly devoted to this question of cancer, and a mass of most valuable information bearing on the subject will be found therein. In that publication, as I have observed, Dr. Newsholme adheres to the view expressed in the paper by Mr. King and himself, to which I have frequently referred, and maintains that the statistics "do not justify the conclusion that an increase in cancer mortality has occurred within recent years. They rather tend to the conclusion that the increase in cancer is only apparent, and is due to improved diagnosis and more careful certification of the causes of death—especially to the latter." Dr. Roswell Park, of Buffalo, N. Y., on the contrary, refers to the carefully prepared returns of the State Board of Health, and says: "so far as we have been able to learn, cancer is now the only disease which is steadily on the increase * * *. Thus, for instance, in 1887, there were in New York State 2,363 deaths from cancer, and 11,609 from consumption. In 1898, there were 4,456 deaths from cancer, and only 12,552 from consumption. This increase in cancer mortality is certainly not due to improvements in methods of diagnosis, but rather is the reverse the case, since many cases which were formerly diagnosed as cancer are now properly classified where they belong in other lists. In none of the other diseases tabulated by the State Board of Health, nor in any Government Reports, has there been such an immense increase as in cancer. It is the only disease tabulated which shows a progressive and steady increment by months and by years."

The statistics for Great Britain and Ireland, and the opinions of European and American authorities, are, however, doubtless, quite familiar to investigators in Europe and America, and it will be more to the purpose to supply some statistics perhaps not quite so well known, and to ascertain how far they confirm the teaching of those already quoted.

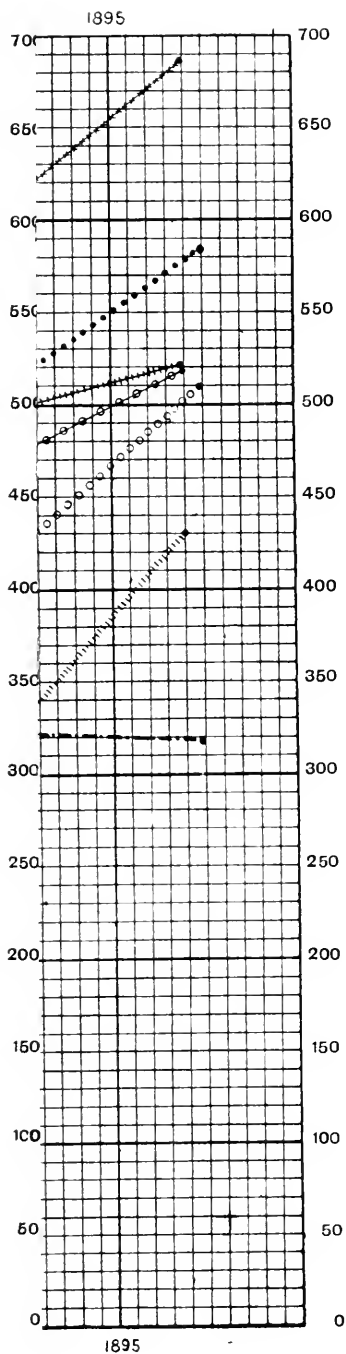
In Table VI, I give the figures relating to the Australasian

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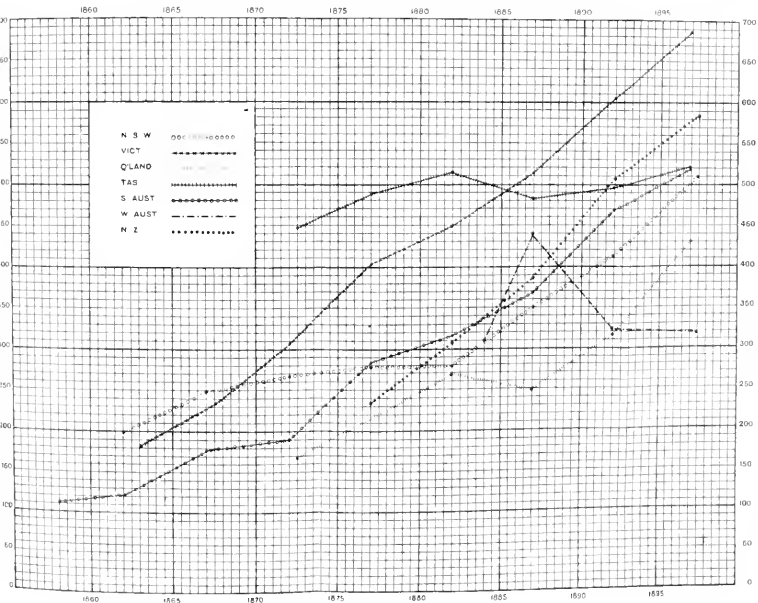


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AVERAGE ANNUAL RATE OF DEATH FOR EACH QUINQUENNIAL, PER MILLION OF MEAN POPULATION



Colonies. Leaving out of consideration the case of West Australia, the population of which was suddenly and rapidly increased by a large influx of persons in the prime of life, attracted thither by the phenomenal gold discoveries, it will be seen that the figures tell the same tale as those already quoted, namely, an unvarying increase in the cancer death rate from beginning to end. This increase cannot be accounted for by the increase of population at the old ages. Taking the two great colonies of New South Wales and Victoria, the respective numbers and proportions of the people under and over 45 years of age, were, at the last three census periods, as under :

Census Period	N. S. WALES				VICTORIA			
	Under 45	Per-cent	45 & over	Per-cent	Under 45	Per-cent	45 & over	Per-cent
1871	435,565	86·4	68,416	13·6	624,107	87·6	88,116	12·4
1881	646,008	86·0	105,460	14·0	701,398	82·6	148,040	17·4
1891	970,583	85·7	161,651	14·3	940,830	83·2	189,633	16·8

These figures show that there has been but little variation in the proportion of the population over 45 years of age, except in the case of Victoria, between the census periods 1871 and 1881. Generally speaking, while the proportion of the population at the different age-periods has remained almost constant, the rate of mortality from cancer has steadily increased. The constantly upward movement of the rate and the intensity of the increase in the cancer mortality are graphically set out in the diagram appended hereto.

It has been shown in Table IV that the experience in a general population is repeated when we come to deal with selected lives in a life office such as the Scottish Widows' Fund. This old-world experience is seen to be reproduced in that of the new among a similar class of lives. In Table VII is given the experience in the Australian Mutual Provident Society, the largest mutual life office in the British Empire. Omitting the earlier years, in which the numbers are too small to admit of accurate deductions, we find the same constant increase, not accounted for by the increasing age of the persons under observation, for, owing to the large issue of endowment assurance policies, the average age of the lives assured has remained nearly constant for many years. Can it be maintained that these constant increases in the death

rates, in two hemispheres, in the general population as well as among assured lives, are consistent with the theory that the increase is only apparent—due to improved diagnosis—and not real? I confess I am unable to share this view. A singular exception, however, to the view I have taken appears to be furnished by the latest tabulated experience of the Mutual Life Insurance Company of New York. I have above quoted the remarks of Dr. Roswell Park regarding the increase in the cancer mortality of New York State. In the report of Drs. Marsh and White on the mortality experience of the Mutual Life Insurance Company of New York for the years 1843–1898, a table is given on page 23 exhibiting the cancer deaths at ages 50 to 70 for the years 1879 to 1898. The percentages to total deaths are :

1879 to 1888	.	.	.	5.6
1889 to 1898	.	.	.	6.3

The total deaths were 10,646, of which 1,000 were from cancer. In a previous report of Drs. Winston, Gillette, and Marsh for the years 1843 to 1874, it was said: “It may be said in round numbers that there are twice as many deaths from cancer among the male population of New York as in the experience of this company.” The numbers tabulated were, however, too small to warrant any definite conclusion. In the later report the statistics are not presented in a form to allow of accurate deductions, but the investigators say: “It is here seen that the increase in the cancer rate within twenty years has been small and irregular, and not at all corresponding to that given in the reports of the mortality statistics of Great Britain and the United States. The increase is so small that it can best be accounted for by greater accuracy in diagnosis.” It appears to me that this isolated example can scarcely be held to negative the teaching of the statistics I have already quoted.

I arrive at the conclusion, then, that the mortality from cancer has certainly and largely increased, and is still increasing. It behoves us, then, to inquire what is the cause of this increase. Is the disease infectious or hereditary; does it give any indication of its approach? In the *Journal of the Royal Statistical Society* for 1898, p. 561, it is said: “When excessive quantities of such highly-stimulating forms of nutriment are ingested by persons whose cellular metabolism is defective, it seems probable that there may thus be excited in those parts of the body where vital processes are still active such excessive and

“disorderly cellular proliferation as may eventuate in cancer.” This, though a very striking piece of composition, appears to be a somewhat evasive generalization. The editor of *The Practitioner*, in the number already referred to, writes: “Verneuil, some years ago, said that he and other hospital surgeons in Paris had been struck by the much greater number of cases of cancer of the tongue and other visible parts that came before them than had been the case thirty or forty years before. He attributed the fact to the increasingly carnivorous habits of the population. The vegetarians naturally hailed this suggestion with enthusiasm, till it was pointed out that cancer is just as prevalent among the mild Hindus, to whom the flesh-pot is an abomination, as among the ‘cow-eaters’ whom they despise. Among ourselves there appears to be a wide spread popular belief that the pleasant and harmless, if not exactly necessary, tomato has something to do with the production of cancer.” As increasing attention is being given to the cure of this terrible and fatal disease by the medical faculty all the world over, and as there can be little hope of the discovery of any cure until its cause has been ascertained, we may look forward with hope to the researches of those investigators who are devoting themselves to this aspect of the inquiry.

The question whether the disease is contagious or infectious is of vital importance to the community at large, while the cognate one of heredity is one which nearly concerns life assurance offices. Dr. Roswell Park, in his article in the number of *The Practitioner* to which I have already alluded, sums up an apparently exhaustive inquiry in these words: “It will be enough for the present if I say that both cultures and inoculations have been so often successful as to leave no doubt in the minds of those who are doing this work that cancer is unmistakably a parasitic, *i.e.*, an infectious disease.” Isolated cases cannot, of course, be taken as very strong evidence in favour of any general rule, but the following, which has come under my own observation, may not be without interest: A lady resident in a capital of one of the Australasian colonies died from cancer of the uterus. Her eldest son married a wife in no way related to his family, and the newly-married couple occupied the house in which the husband’s mother had died. The young wife died from cancer of the uterus. A second son married a lady in no way related to his own or his deceased sister-in-law’s family, and occupied the fatal house. His wife also died from cancer of the

uterus. A third son was about to marry, with the intention of occupying the same house, but the lady who was to be the wife, on the advice of a medical gentleman whom she consulted, declined to live in the house which had obtained so evil a reputation.

It is still more difficult to determine the question of heredity. In the case of consumption the dispute between the germ theory and heredity is by no means settled. Nevertheless, the probability of the occurrence of consumption appears, for practical purposes, to be independent of the merits of this dispute. In the practical business of life assurance the poorly-developed, small-chested, under-weight proponent, with a family history of consumption, stands a poor chance of misleading the medical examiner or the actuary. No such danger signal is visible as a warning to the most careful observer against the probability of cancer.

The following figures relate to 253 deaths from cancer occurring among the lives assured in the Australian Mutual Provident Society during the years 1849-1888 :

	Total Deaths	From Cancer	Percentage Cancer
Males . . .	5,237	228	4·4
Females . . .	214	25	11·2

An attempt has been made to trace the influence of heredity, and to this end the family history in each case has been examined, and a division made into "Good, Doubtful and Bad." "Good" cases are those in which no cancer taint was disclosed. In the "Doubtful" cases were included those in which the death of some member of the family was ascribed to tumour and those in which a mother or sister had died from some undefined internal trouble; also those in which the cause of death of any member of the family was unknown. "Bad" cases are those in which cancer was acknowledged as the cause of death of one or more members of the family. The numbers are too small to admit of any more minute subdivision. The following table gives the result of this attempt :

Family History	Total Deaths	AVERAGE		Cancer Deaths	Percentage of Total
		Age at Entry	Years' Duration		
MALES					
Good .	3,294	34.0	8.4	134	4.1
Doubtful .	1,807	40.3	9.6	85	4.7
Bad .	136	38.2	8.0	9	6.6
FEMALES					
Good .	134	34.8	5.9	12	9.0
Doubtful .	70	43.2	8.8	10	14.3
Bad .	10	42.2	7.8	3	30.0

The singular consistency of the ages and durations between the different classes of males and females is possibly only a coincidence, but it is worthy of note. The numbers under review, especially in the case of females, are too small to warrant any definite conclusion being drawn from them, but the indication appears to be too clear to be disregarded.

In the *Contemporary Review* for July 1899, Dr. Woods Hutchinson writes: "In spite of the ravings and gallery-play of 'the Lombroso mountebanks anent 'degeneracy,' our bills of 'mortality show a marked diminution in the fatality of every 'important disease which affects humanity save one. Those of 'the profession who see the most of cancer are almost unanimously 'of the opinion that it is slowly increasing, and almost equally 'so that this is due to the greatly diminished death rate from 'the diseases of infancy and childhood and young adult life . . . 'and hence the much larger number of individuals which reach 'and pass adult life. In short, to use a Hibernicism, cancer is 'increasing because more people are living long enough to die of 'it. It cannot be too strongly emphasized that cancer in its 'early stages is a distinctly curable disease; in its later almost 'incurable. Cancer, ruthless as it is, has one redeeming feature; 'it does not threaten the existence of the race, nor ruin the 'individual life. The best of the life-work is done, the family 'reared, the vantage ground for the world's progress won, before 'the dart is launched. Between dying of consumption at 'twenty-five and of cancer at fifty lies practically an entire 'lifetime. Few of us would hesitate for a moment if given

“our choice. Surely even two years of suffering is not too much to pay for fifty of vigorous successful life.”

I fear that to life assurance offices at least this breezy tone will bring but a small degree of satisfaction.

The question which I have thus briefly and imperfectly discussed appears to me to be one in which life offices are largely and directly interested; it is one which has not hitherto received from them the attention which its importance demands; and if my remarks have the effect of stimulating inquiry and of leading to the production of more extended and possibly more conclusive statistics, especially from the experience of life offices, my object will have been attained.

TABLE I.

Mortality from Cancer in England and Wales per Million living at all Ages.

Years	Males	Females	Persons
1851-1860	195	434	317
1861-1870	244	523	387
1871-1880	315	622	473
1881	364	668	520
1882	364	692	534
1883	381	702	549
1884	405	707	563
1885	411	713	572
1886	424	733	572
1887	456	748	615
1888	450	761	621
1889	488	790	656
1890	512	830	676
1891	518	855	692
1892	528	843	690
1893	550	863	711
1894	555	861	713
1895	586	914	755
1896	618	901	764
1897	636	929	787

TABLE II.—Population, and Deaths from Cancer, England and Wales.

Age	1860-1866		1867-1873		1874-1880		1881-1887		1888-1894		1895-1897	
	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer
MALES												
25-35	10,065,013	603	11,026,867	729	12,120,353	840	13,209,827	983	14,225,686	1,410	6,434,973	614
35-45	8,127,262	1,604	8,599,671	1,862	9,416,398	2,326	10,283,966	2,953	11,073,974	4,010	5,009,028	2,058
45-55	6,096,059	3,132	6,654,352	4,073	7,044,307	5,108	7,480,991	7,147	8,063,966	9,883	3,650,234	5,173
55-65	4,067,022	4,512	4,444,718	6,032	4,835,955	8,088	5,237,894	11,174	5,611,999	14,876	2,552,577	8,169
65-75	2,201,801	3,936	2,450,509	5,273	2,636,088	7,181	2,824,396	9,999	3,043,499	14,143	1,377,346	7,646
75 & over	852,983	1,855	917,480	2,395	983,176	3,084	1,055,489	3,921	1,137,273	5,414	514,617	3,059
Total	31,413,143	15,612	34,090,597	20,364	37,036,277	26,630	40,092,563	36,177	43,186,397	49,736	19,538,805	26,749
FEMALES												
25-35	11,210,266	1,772	12,156,572	2,053	13,205,566	2,304	14,331,599	2,463	15,516,891	2,880	7,024,722	1,320
35-45	8,709,359	5,700	9,331,309	6,784	10,154,306	8,187	11,051,894	9,309	11,975,985	10,812	5,424,985	5,146
45-55	6,458,701	9,552	7,117,098	11,578	7,698,205	13,991	8,282,058	16,694	8,969,895	20,515	4,061,739	9,826
55-65	4,382,534	9,540	4,851,654	12,109	5,377,469	15,463	5,902,299	19,044	6,387,792	23,643	2,890,979	11,964
65-75	2,562,017	6,881	2,835,339	8,747	3,095,421	11,304	3,361,830	14,753	3,639,769	20,016	1,647,741	9,912
75 & over	1,113,831	3,041	1,208,216	3,723	1,290,244	4,710	1,383,783	6,110	1,498,870	8,456	678,769	4,703
Total	34,436,708	36,486	37,530,188	44,994	40,821,211	55,899	44,313,463	68,373	47,989,202	86,922	21,728,935	42,871

TABLE III.—*Annual Death-rate from Cancer per Million living at each Age Period (see also Table II).—England and Wales.*

Ages	1860-1866	1867-1870	1874-1886	1881-1887	1888-1894	1895-1897
MALES						
25-35	59.91	66.11	69.31	74.11	99.12	100.08
35-45	197.36	216.52	247.02	287.15	362.11	410.86
45-55	513.78	612.08	725.13	955.36	1225.58	1417.17
55-65	1109.41	1758.03	1672.47	2133.30	2636.65	3200.30
65-75	1785.19	2151.80	2725.25	3540.23	4646.95	5551.26
75 & over	2174.72	2610.41	3136.77	3714.87	4760.51	5943.88
FEMALES						
25-35	158.07	168.88	174.47	171.86	185.60	187.91
35-45	654.47	727.02	806.26	842.30	902.81	948.57
45-55	1478.94	1619.96	1817.44	2015.68	2287.09	2419.16
55-65	2176.82	2495.85	2864.36	3226.54	3701.28	4138.39
65-75	2685.78	3084.99	3651.85	4388.38	5499.25	6015.51
75 & over	2730.22	3161.17	3650.47	4415.43	5641.58	6928.72

TABLE IV.—*Annual Deaths from Cancer per Million living, aged 25 and over. Population distributed in age groups according to English Life Table No. 3, Persons.*

Country	Years	Under 55	Over 55	Total
MALES				
England and Wales	1860-66	165	160	625
	1867-73	189	558	747
	1874-80	220	691	911
	1881-87	277	875	1,152
	1888-94	355	1,116	1,471
	1895-97	404	1,353	1,757
FEMALES				
England and Wales	1860-66	489	748	1,237
	1867-73	537	859	1,396
	1874-80	595	999	1,594
	1881-87	644	1,166	1,810
	1888-94	715	1,414	2,129
	1895-97	753	1,596	2,349
MALES AND FEMALES				
Scottish Widows' Fund	1860-66	193	431	624
	1867-73	223	733	956
	1874-80	158	824	982
	1881-87	195	948	1,143
	1888-94	266	1,010	1,276

TABLE V.

*Deaths from Cancer per Million of persons, age 25 and upwards,
distributed in age groups according to the English Life
Table No. 3.*

Year	ENGLAND AND WALES		Year	ENGLAND AND WALES	
	Males	Females		Males	Females
1860	587	1,185	1880	995	1,680
1861	597	1,200	1881	1,020	1,705
1862	608	1,215	1882	1,058	1,737
1863	619	1,235	1883	1,101	1,775
1864	637	1,254	1884	1,143	1,805
1865	655	1,273	1885	1,197	1,840
1866	672	1,297	1886	1,245	1,880
1867	685	1,320	1887	1,300	1,928
1868	705	1,342	1888	1,341	1,985
1869	725	1,366	1889	1,393	2,038
1870	747	1,394	1890	1,445	2,100
1871	767	1,421	1891	1,465	2,184
1872	790	1,450	1892	1,505	2,465
1873	810	1,479	1893	1,557	2,208
1874	832	1,507	1894	1,578	2,202
1875	857	1,537	1895	1,667	2,337
1876	880	1,565	1896	1,788	2,316
1877	908	1,594	1897	1,817	2,392
1878	940	1,623			
1879	965	1,652			

TABLE VI.
Deaths from Cancer in the Australasian Colonies.—Average Annual Rates, in each Quinquennium, per Million of Mean Population.

Years	New South Wales	Victoria	Queensland	Tasmania	South Australia	West Australia	New Zealand	Years
1857-59	...	...	...	...	111.4	...	...	1857-59
1860-64	198.4	(a) 182.6	...	...	120.9	...	...	1860-64
1865-69	248.4	233.1	...	...	176.4	...	...	1865-69
1870-74	267.3	307.2	(b) 165.2	(b) 447.3	190.0	...	...	1870-74
1875-79	276.7	404.1	214.9	488.3	284.7	...	233	1875-79
1880-84	278.6	449.8	267.8	514.1	314.7	(c) 309.3	306	1880-84
1885-89	349.9	512.9	249.4	480.7	366.9	440.0	385	1885-89
1890-94	412.4	603.9	313.7	496.5	467.6	321.5	506.3	1890-94
1895-99	510.2	686.4	430.3	521.3	517.8	317.9	583.8	1895-99

(a) Years 1862-64 only.

(b) " 1871-74 "

(c) Year 1884 only.

TABLE VII.

Approximate Number of Lives (Male and Female) at Risk at middle of each Year, and Deaths recorded from Cancer in each year in the Australian Mutual Provident Society.

Year	Lives at Risk 30th June	Deaths from Cancer	Deaths per 1,000,000 Lives exposed	Average Annual Death Rate per 1,000,000 for each Quinquennium	
1863	3,196	2	625.8	272.9	1863-64
4	4,134	...	...	...	...
1865	4,962	...	...	...	...
6	5,702	...	...	...	...
7	6,485	2	308.4	90.9	1865-69
8	7,363	1	135.8	...	...
9	8,495	...	...	...	...
1870	9,650	1	103.6	...	...
1	10,960	4	365.0	...	...
2	12,516	1	79.9	200.5	1870-74
3	14,607	3	205.4	...	...
4	17,109	4	233.8	...	...
1875	19,715	6	304.3	...	...
6	22,696	4	176.2	...	...
7	25,983	10	384.9	335.6	1875-79
8	29,860	7	234.4	...	...
9	32,864	17	517.3	...	...
1880	36,353	12	329.8	...	...
1	39,647	18	454.0	...	...
2	42,953	17	395.8	381.7	1880-84
3	46,891	19	405.2	...	...
4	51,554	17	329.8	...	...
1885	57,492	25	434.8	...	...
6	64,149	21	327.4	...	...
7	69,831	28	401.0	445.3	1885-89
8	74,527	38	509.9	...	...
9	79,810	42	526.2	...	...
1890	86,096	40	464.6	...	...
1	92,808	50	538.7	...	...
2	99,356	36	362.3	489.7	1890-94
3	103,717	57	549.6	...	...
4	106,038	56	528.1	...	...
1895	108,536	54	497.5	...	...
6	111,850	64	572.2	...	...
7	116,070	60	516.9	520.1	1895-99
8	122,120	63	515.9	...	...
9*	129,722	65	501.1	...	...

* Returns for 1899 not yet complete.

DISCUSSION.

The PRESIDENT (Mr. C. D. Higham) looked upon the paper as a very interesting one, and expressed his pleasure at the fact that it had brought so many medical friends to the meeting. Actuaries carried on a many-sided life. They were brought into contact during the day with a great many men—with the lawyer, the stockbroker, the banker, the economist, but especially with the physician and surgeon. Of the importance of the subject there could be no question; for, whether cancer was increasing or not, it was a malignant disease carrying off its thousands year by year; and if, by raising the question, some suggestion might be thrown out which would help to prolong life or diminish suffering, the evening would not be wasted. Of course, it was the great fact of life or death that chiefly concerned actuaries, and it was not their business to keep people alive, although they were grateful to those who did so; but, quite irrespective of any professional interest, as citizens they did care for anything which was for the good of the population at large.

Mr. GEORGE KING, in opening the discussion, alluded to the difficulty he felt in dealing with the subject, because it was largely medical, but said he had had the very great advantage eight years ago of going into the question with his friend Dr. Newsholme, and, through the courtesy of the Royal Society, the paper which they then wrote had been resuscitated for use on the present occasion. In undertaking the preparation of that paper, their object had been twofold. In the first place, the question of cancer was a very important one, and there had been a great deal of discussion, which still continued, as to whether it was increasing or not. Different views were held by different people, and the Registrar-General's office seemed at different times to look at the matter from opposite sides. They therefore had thought it would be useful to collect together all the statistics available, analyze them, and see what they really taught. But they had had another object, which was to try to show in what way such subjects could be best dealt with. Statistics were often very fallacious, and, relating to such a disease as cancer, were especially so. The incidence of cancer was so entirely a function of age that the question of age distribution became of the utmost importance. For instance, according to the Scottish Widows' Fund, at ages 25 to 35 the rate of mortality from cancer was only 61 per million, whereas at ages 75 and over it was 6,374 per million, or more than a hundred times greater. Such being the case, it was clear that the question of age distribution was of paramount importance. The various sets of statistics of cancer should be brought to a common denominator by assuming a uniform age distribution, and Dr. Newsholme and himself had pointed out that it did not matter much what that age distribution was so long as it was reasonably applicable to the circumstances, and so long as it was applied to all the sets of statistics alike, and thus they were able to compare accurately the rate of cancer at different times in different populations and in different classes of those populations. Mr. Teece had taken up the question in one sense where they had left it off, but he had not done so with any completeness, because, while he had adopted the common denominator for the

home statistics, he had altogether ignored it for the colonial statistics and the statistics of the Australian Mutual Provident Society. He thought in doing that he had made an unfortunate mistake. In Table D of the paper written by Dr. Newsholme and himself it would be seen how the age distribution exercised a very extraordinary effect; and in dealing with the Irish statistics it would be found that their teaching, when age distribution was allowed for, was practically reversed. A similar thing occurred in Mr. Teece's paper. In his little table regarding New South Wales and Victoria, there appeared to be but a small change in the age distribution, and Mr. Teece dismissed those tables with a few airy words, treating that small change as of no great consequence. There, he ventured to submit, Mr. Teece was mistaken. Applying the rates of cancer in England and Wales from 1888 to 1890 to the ages given by Mr. Teece, he found that when in the year 1871 there were 87·6 per-cent of the population under 45, the rate of mortality from cancer came out in the entire population at 467 per million; but taking the year 1891, when the distribution was changed to 83·2 under 45, or only 4·4 per-cent difference, that change alone raised the rate of cancer on exactly the same statistics to 562, so that a slight change in the age distribution, without any change whatever in the rate of cancer, raised the apparent rate from 467 per million to 562 per million. Thus a very considerable amount of the increase in rate shown by Mr. Teece, and exhibited in his diagram, was accounted for. Similarly, with regard to the figures of the Australian Mutual Provident Society, Mr. Teece stated that, on account of the influx of many young members, the average age was nearly constant. But that was not enough. A hypothetical office could be imagined where there was no cancer below age 50, and heavy cancer above age 50—that was an exaggeration of the true facts, but it only emphasized the argument and did not vitiate it. As long as there were no lives below age 50, the death rate from cancer under those circumstances would be nil, but when the office had lasted a little longer, and a good many lives passed over the age of 50, then, although with the influx of new members the average age might be kept down, the age distribution would change, and there would be a death rate from cancer. It was no use merely taking the ratio of the deaths to those insured; the question must be investigated from the point of view of age distribution. From those considerations, which he thought were perfectly unassailable, the figures given by Mr. Teece for the Australasian colonies and the Australian Mutual Provident Society seemed to him not to have much value. They showed, however, a very low rate of mortality from cancer compared with the old country, and that, he thought, was due to two causes. In the first place, to the very low average age of the population. In England and Wales there were 42 per-cent of the population aged 45 and over, whereas in Victoria there were only 17 per-cent, and that made a very great difference in the incidence of such a disease as cancer, which must be allowed for in comparing the figures. Then he could not help saying that in a new country, widely scattered, the certification of such a cause of death as cancer was specially defective. The certification was no doubt rapidly improving with the more methodical arrangements that took place; but in times past, and even at the present time, he

doubted very much if it was so effective as it was in the old country. Therefore, he thought, for that cause alone, the registered mortality from cancer in the Australian colonies must be small compared to what it was here. The general conclusions come to by Dr. Newsholme and himself in their paper were: first, that where there was inadequate medical attendance the death rate from cancer, as registered, was low, and it rapidly increased as medical attendance and certification improved; secondly, that the apparent increase of cancer, as shown by the figures, was due almost entirely to what they had called inaccessible cancer—cancer difficult of diagnosis. In accessible cancer there was very little increase apparent in the figures that were available. Thirdly, the apparent increase in cancer was greater in males than in females, and it was found that males suffered much more from the inaccessible form than from the accessible; fourthly, the deaths from accessible cancer in the female had remained almost uniform, and the apparent increase in inaccessible cancer in both sexes had been almost the same. The Frankfort figures had been assailed from many quarters. Dr. Payne had criticized them, and had tried to minimize their import by showing that they were few, and, therefore, he said, not very trustworthy. He (Mr. King), however, thought that in the very cautious way Dr. Newsholme and himself had used them they could be dealt with safely. They had not placed very great weight on them in themselves; but, although they were comparatively meagre, they were entirely consistent with each other from period to period. They were not erratic, and therefore from that point of view they were entitled to weight. Moreover, wherever confirmation was possible, they were confirmed from other sources; and, just as the straw would show which way the wind blew, so small statistics, consistent in themselves, and confirmed elsewhere, were of very great value. The question that evening was not so much the cause of cancer as whether it was increasing or not, but one or two points dealing with the cause had been brought up in Mr. Teece's paper as bearing on the question of increase. For instance, he mentioned heredity. The statistics available for estimating the heredity of cancer were very defective. It was no use whatever only taking the cases that died of cancer, and investigating their family history. To get at the truth it was necessary to take the cases that died of something else, and investigate their family history also. Until that was done, and it was shown there was a stronger family history of cancer in those who died of it than in those who did not, not much way had been made. All the statistics he had seen on the question of heredity dealt only with those who died of cancer, those who came to the hospitals with cancer, and so on, and, therefore, he did not think statistics of that kind were of any great value. Another point was one which had been taken up by Dr. Payne in a paper he wrote for the Life Assurance Medical Officers' Association, in which he said that if cancer was hereditary then it must constantly increase, because the hereditary tendency would go on increasing in the population. That, he thought, was a fallacy. With an old population such as the world contained, the effects of such a cause must reach a maximum and then remain stationary; and he had not the slightest doubt in his own mind that if cancer was hereditary, which he himself rather doubted, the force of heredity had now

reached its maximum, and was not increasing. With regard to whether cancer was increasing or not, people assumed that it was, and tried to give a reason. The much higher living of the labouring classes was given as a very special cause, but he doubted whether that had any effect at all. To attribute cancer to that source was a gratuitous assumption. It was quite true that during the last fifty years the labouring classes had been better fed and better housed, and that during the same period cancer had apparently been increasing, but he did not think himself that that was cause and effect. He had seen it gravely argued that uncivilized nations suffered very little from cancer because they lived simply and lacked civilization, but he would ask who was Registrar-General of the savages, and who certified their deaths? He thought that rather tended to show that Dr. Newsholme and himself were right — that it was improvement in diagnosis and more careful certification of the causes of death that brought about the apparent increase. In the same way he had seen it stated that wild animals did not suffer at all from cancer, and that domestic animals did, and that, therefore, civilization created cancer. But there, again, who registered the deaths of the lions and tigers in Central Africa? It was absurd. It was purely a question of watching and diagnosing the disease and certifying it. Mr. Teece very candidly admitted that the "mild Hindoos" suffered from cancer, although they were vegetarians. That he believed was a fact; so that if cancer was due to eating meat there was something to be explained there. The main point taken up by Dr. Newsholme and himself in their paper was that improved certification was the great element in the apparent increase of cancer, but that point was entirely ignored by Mr. Teece. Mr. Teece spoke of diagnosis, but he left certification alone. He (Mr. King) thought that doctors were far more careful in certifying to disease than they used to be. The Registrar-General frequently wrote to medical men for further details when he received doubtful certificates. Although, perhaps, only comparatively few deaths were transferred from one class to another on account of these letters, yet the fact that they were liable to receive such letters made doctors certify more carefully. Then Mr. Teece really gave himself away when he said that increasing attention was being given to the cure of the terrible and fatal disease by the medical faculty all the world over. The doctors now made special note of the cases, and that seemed to account for the certified increase of deaths from cancer. Had there been no apparent increase since the time Dr. Newsholme and himself closed their inquiry he should have said there was something wrong in their hypothesis, but the very fact that the increase had been going on steadily seemed to show that they were right. There was still much room for improved diagnosis and certification, and therefore the registered rates of death from cancer must continue to increase until they reached their limit. He thought it was more logical to say that it was a change in statistical methods that was producing the apparent increase than that there was so terrible a change in the laws of Nature.

Dr. PAYNE said he had for many years given a good deal of attention to this subject, and did not altogether agree with the deductions which Dr. Newsholme drew from the recorded facts. He

had lately been studying the New Zealand statistics, and with regard to these the compiler of the statistics asked whether the great increase in recorded cancer was due to a change in age distribution, that was, to an increasing number of persons living in advanced ages, and came to the conclusion that that was not so. He thought everyone would agree that the hypothesis of the increase of cancer being due to greater longevity in the population was altogether untenable. According to the census of this country for 1891, it was found that the number of persons living at higher ages had not increased. There was a very general impression that longevity was increasing, and he thought it was very possible, although difficult to prove. That was the case with regard to the upper and generally well-fed classes. But, even if it was so, it did not follow at all that that would affect the statistics, because statistics were founded on the mass of the population. The question which had been proposed was, whether the increase in recorded cancer was due to a greater accuracy of diagnosis. Dr. Newsholme and Mr. King had gone a long way back, and had begun with what one might now call the dark ages. In statistics obtained in the "dark ages" very likely there was a great fallacy. It was found now that the increase was progressive: there had been a great increase in the last ten years, so that if it was due to improvement of diagnosis and observation, it must be supposed that a great change had taken place in that time, but from his own experience he thought he must deny that, as he believed that in 1890 cancer was diagnosed and recorded with the same accuracy as in 1900. With regard to the other argument, that the increase had been in certain classes of cancer, that was true, but it was not at all true in the way in which it had been put by Mr. King and Dr. Newsholme. The question was not a new one, the argument being first put forward by Dr. William Ogle in his report for the year 1883. Dr. Ogle only spoke of the English statistics, and said the death rate for females was increasing more rapidly than the death rate for males. It was a curious fact that at that particular time, if Dr. Ogle had looked at the statistics for Scotland, he would have found that was not the case. For a few years Scotch statistics were rather in favour of the female sex. Since then the rate of increase of males over females was much greater. Then it was said that the females suffered chiefly from cancer which was more easily accessible than the males. That had been worked out since, and he thought that was not at all to be understood in the manner in which it had been stated. With regard to the Frankfort Statistics, Mr. King thought he was not right in questioning their value. He acknowledged the skill and ability with which the statistics were treated, but he thought they were not worth all the trouble. It was quite true that cancer of the reproductive organs in women did not increase very much in the City of Frankfort during the period under review. He did not know why, but, whatever the reason might have been, it did not seem to him of sufficient moment to influence the statistics. In Ireland cancer of the tongue was a form of cancer which was increasing very fast, and also cancer of the breast in women. There was also an account of increase of cancer of the liver. His impression of the statistics was that the great increase had been in cancer of the

digestive organs taken as a whole. It was not a question of internal or external, accessible or inaccessible. One very remarkable fact was that the increase in cancer of the liver in the male sex was comparatively small, while the increase in the female sex was enormous. Women died in considerably larger numbers than men of cancer of the liver. In the two years, 1897 and 1898, broadly speaking, 2,000 women died of cancer of the liver to 1,300 men. He could not understand, therefore, that there was any importance to be attached to the question of whether the organ was supposed to be accessible or inaccessible to diagnosis. The important fact was the increase in cancer affecting the organs of digestion that seemed to him to be closely connected with the question of food. There was no doubt that during the period in which the increase of cancer had been observed there had been a change in the food of the population of this country. The working classes had become flesh eaters to a larger extent than they were before, and it was the working classes that made statistics. There was a general impression, which might or might not be correct, that cancer was commoner in the upper classes. It seemed to him that a most important factor in cancer was that the working classes had for the last 30 years or more been put on a level with the more wealthy classes in the matter of food. He had another reason to think it was in some way connected with food. There was a general impression among Indian doctors that cancer was not common in India. Although there were a certain number of operations in India, the population were not treated by educated doctors, capable of giving proper death certificates. Therefore, no one could say there were any comparable statistics at all. There were in India a very large number of hospitals and dispensaries, and very elaborate reports were issued by them, and the number of persons embraced in those reports amounted to several millions. The number of in-patients was also very large. Among the in-patients there were a great many operations, and the death certificates were given very carefully. A large number of operations were put down to the removal of tumour, but, nevertheless, the operations for cancer of the breast were only 8 or 9. It might be said that women did not go to the Indian hospitals, but they did, although not in the same numbers. He believed it was true, although he could not give figures, that cancer appeared to be exceedingly uncommon in India, and, as was well known, the food of the population was chiefly vegetarian. It was also stated that it was much commoner in Japan than in India, and it was common in several parts of China. So that he thought there was an undoubted connection between cancer and food, and, as he had said, there was an increase of the disease in the organs connected with the taking of food. It did not follow that mere high nutrition was favourable to cancer. There were at least two other ways in which it might be accounted for. It might be that taking a quantity of meat brought the whole body into a condition more favourable to cancer; and then, again, it might be the case that the immediate parts of the digestive tract concerned with the food were brought into connection with matter that might stimulate them in an exceptional manner. It might be due to some particular germ introduced into the body by means of

the food. That, although by no means proved, was also very plausible. With regard to diagnosis, he might mention one other fact. There was a great increase in the amount of cancer admitted in the hospitals. He had gone into the statistics of St. Thomas's Hospital very carefully. The hospital had a larger area to draw from than most hospitals, and it was found that the proportion of cancer to other diseases admitted increased, and that the proportion of cancer of the different organs had altered very much. In the hospital years ago the number of cases of cancer of the female reproductive organs was much larger than all the other forms put together. Now the number of cases of cancer of the digestive organs was nearly five times as large as that of the reproductive organs. It amounted to a revolution. Dr. Newsholme might say that was diagnosis, but for the period 1870 to 1880 the physicians to St. Thomas's Hospital were Dr. Murchison and Dr. Bristowe, and he did not think it would be said that those eminent physicians made a mistake in the diagnosis, and he did not think the post-mortem examinations were carried out less efficiently then than they were at the present day.

Dr. GLOVER LYON believed Mr. Manly and himself were the first actuary and physician to combine their efforts to arrive at the truth with respect to mortality experience in any particular disease. The disease they were concerned with then was consumption, and he remembered very well quoting a remark from Dr. Bristowe to show how entirely fallacious, and even misleading, was medical experience on those matters. The quotation was that he said consumption was very common in childhood, and was most common between the ages of 20 and 25. That was utterly misleading. The mortality from consumption was highest between 40 and 45. It was about equal between the ages of 60 and 65 and 20 and 25. What struck him in listening to Dr. Payne was how much greater repose there was in the paper read at the Royal Society by Mr. King and Dr. Newsholme than in the present paper, and he thought that repose came from the fact that a doctor and an actuary combined together and brought proper methods to bear on the subject. When Mr. Manly and himself wrote the paper they took it for granted, and enunciated the fact, that consumption was an infectious disease, and they pointed out that such a disease had three elements—heredity, habit, and infection. In dealing with cancer it was necessary to go into those things again. He thought doctors should look at it from their own point of view, and leave the actuaries to decide the statistics. The medical point of view must be an individual one. Supposing an individual presented himself for insurance, was he more likely to die by cancer than a man who presented himself ten years ago? He did not think statistics proved whether he was or not. Dr. Newsholme and Mr. King did their best to dispel any fallacy due to bad registration, and they went to a place where the numbers registered were small, but also where confirmation was secured by post-mortem examination. He suggested that actuaries should assist by going into experience on their books, by seeing the number of deaths of cancer compared with other deaths, and in that way obtain some very valuable information on the subject.

Mr. R. P. HARDY said that at the last meeting the members were agreeably instructed by a paper that had come across the Atlantic, and that night they had to welcome another over-sea communication hailing from still further, but equally bearing that fraternal greeting which was one of the happy notes of membership, showing that neither distance nor climate nor intense pre-occupations abated that diligent interest the members continued to feel in their own profession. With regard to the paper of the evening, he hoped that the medical men present would remember that Mr. Teece was a practical man engaged in the business of life assurance, and give due weight to his observations. He thought it was a most happy suggestion that the paper of Dr. Newsholme and Mr. King had been reprinted and circulated that evening. He had read that paper with peculiar pleasure and with a great deal of instruction. A study of the two papers would show how dangerous it was to dogmatize upon the basis of an imperfect collocation of facts that were heterogeneous in certain important particulars; and how difficult it was, even for experts, to make the full legitimate logical induction and track the law to its isolation, or even to demonstrate beyond reasonable challenge that the law had remained constant in its operation, despite certain apparent manifestations to the contrary. Mr. King's paper was an excellent lesson in sound statistical method. Amongst other things it taught the fact that one must not be content with a mere popular description of an event, but must require the groups to be scientifically analyzed and technically labelled before tabulation. Again, he would draw attention to the much-needed warning against the prevalent error of assuming a common age in all populations reviewed. One scarcely took up a volume of statistics without finding the death rate of the whole population treated as appertaining to a single age. Also, that it was very important to guard against hasty conclusions drawn from the data of an insurance company, where the age distribution might alter the relation of the facts, and, further, the very important distinction between the accessible and non-accessible cases of cancer. There was a great deal in all that, and the lesson could not be too thoroughly learned and applied in other directions. On the other hand, it was necessary to be just to Mr. Teece, who had approached the subject independently, not merely for business purposes, but as a scientific enquirer, and it was impossible to read his paper without coming to the conclusion that he had been actuated throughout by an evident desire to arrive at the truth, and that he had endeavoured to give full weight to those considerations that Mr. King and Dr. Newsholme had so ably put forward. To make an open confession, he must admit that he was somewhat impressed with Mr. Teece's figures, in which view he was somewhat strengthened by the observations that fell from Dr. Payne, and he thought that the powerful appeal he had made to the court for arrest of judgment was entitled to a very full consideration. He was asked before he came into the room what had the question of cancer to do with the actuaries of life assurance offices, and he was forced to rejoin that there was an interest even beyond the money part of the life assurance. For what did all forms of evil, of pain, of disease, of premature death, imply but that something was wrong—

that we were mismanaging ourselves, or that we did not make sufficient use of the light that was in us? To teach the eye to see those things properly, to recognize the discordance, to distinguish the far-off as well as the near-at-hand causes, was one of the functions of statistics, and was a pursuit truly noble in its aim, although most imperfect in its practice, and not taught upon any scientific basis. He held that unsparing criticism of methods, and the constant challenging of results fell properly within the sphere of the actuary, whose training peculiarly fitted him for the intellectual dissection of facts.

Sir THOMAS SMITH remarked that what he had to say was entirely of a practical nature, and probably had very little interest to statisticians. He joined with the other speakers in congratulating the author of the paper upon his labours and the information he had brought before the Institute. He could not help congratulating him also on the most hilarious aspect of cancer taken by Dr. Woods Hutchinson in the quotation in the paper. In that quotation it was said that 45 years of happy life might well balance two years of a painful disease if a man died between 45 and 50. That was a view which could not be taken in that room by those who had to do with life assurance. Mr. Teece also quoted one or two remarks in the paper which, as a surgeon, he might reasonably fall foul of. It was stated pretty positively that in the early stages cancer was a curable disease. That was a very strong assumption. Those who had most to do with cancer, without absolutely contradicting it, would receive it with a great deal of reservation. It depended, first, on the nature of cancer, and then very largely on the locality in which it occurred. There was only one locality in which it could be said to be curable, and that was the lip. It certainly could not be said generally that cancer was curable ordinarily. Then something was said about the parasitic nature of the disease, and it was assumed that it was parasitic. The first thing to be said about cancer was that nothing at all was known about it, and that was the way in which the truth was more likely to be arrived at finally than by warping the mind with conclusions. Something had been said about the hereditary nature. Those who had to do with the disease knew that there were families in which cancer was prevalent, there were houses in which it was prevalent, and there were localities in which it was prevalent; but it was better to realize those things as facts than to come to any conclusion about them, because exceedingly little was known about the disease, and still less about the appropriate treatment. Although cancer was treated very largely by operation, that was only done for want of any better method.

Dr. HINGSTON FOX was one of those who thought that the increase in cancer was too continuous, too large, too universal, to be explained away by any of the suggestions which had been made which would turn it into an apparent increase only. That, however, was an opinion, and could have but little weight. With regard to the causes of cancer, it seemed to him that Dr. Payne made out a very good case when he dwelt on the increase of cancer in the digestive organs, especially with regard to the increased meat diet, the larger consumption of animal and stimulating food which undoubtedly

accompanied the increased prosperity of the country. He did not think Dr. Payne mentioned what he had pointed out in his paper, that it was those who took largely of alcohol who showed a specially increased mortality from cancer; that brewers, innkeepers, inn-servants, and commercial travellers stood pretty much at the head of the list of occupations which showed most deaths from cancer. He did not put that forward as an explanation of the whole of the increase in question, but it did seem to be an important contribution towards it. There was another cause, if he could succeed in explaining it. It seemed to him that the disease might have increased from the very fact that it was one of those diseases which were incurable. Was that altogether unreasonable, when it was seen that there were certain stray morbid causes that were exercising their ravages amongst the population, such as tubercle, specific fevers, and cancer? If the medical profession was able to do a great deal, as it could do, to check tubercle and specific fevers, both by curing them when they occurred, and preventing them by prophylactic and sanitary arrangements, while, on the other hand, it was able to do nothing, or scarcely anything for cancer, so that that disease was unchecked in its effect on the population, was it unreasonable that that unchecked disease should not only maintain its position in destroying a certain proportion of the population, but actually advance it? It was, in fact, a little like a "survival of the fittest" the other way round; it was not the survival, but the persistence and increase of the fittest disease, the most effective, and the least checked disease. With regard to the question of inheritance, whatever the future might prove about that, at present there were few accurate data. He was one of those who believed there was something in it, and that the common habits which belong to inheritance, common environment, and such things that went to make up what was understood by inheritance, practically did have a great influence in the occurrence of cancer.

Dr. ARTHUR NEWSHOLME considered Mr. Teece's paper was one which brought valuable statistics up to date, and which used correct methods in doing so. He was, however, astonished that the author quoted from an article in the *Contemporary Review* a statement to the effect that cancer was increasing because more people were living long enough to die of it, without any word of disclaimer, or disassociating himself from that erroneous statement. That statement had been sufficiently exposed by previous speakers. It appeared to him that before cancer was spoken about as being on the increase, it was necessary to emphasize the points on which everyone was agreed, and the first was that cancer caused an enormous mortality which it was difficult to exaggerate. In England and Wales in 1898 it was 802 per million; in Brighton, 1900, 830 per million; in Victoria, 1895 to 1899, 686 per million; in New South Wales, 1895 to 1899, 510 per million; and in New Zealand, for the same years, 584. In Frankfort, 10 years earlier, it caused 980 deaths per million of population. Therefore cancer was an enormous cause of mortality, and if there were accurate statements of the causes of death there would be very little doubt that cancer would be shown to be responsible for a death rate of one per thousand of the total population. Comparing by the life table method the population of England and Wales with that of

Frankfort for ages over 25, it would be found there was an increase still possible before reaching the Frankfort amount of 32 per-cent for males, and 50 per-cent for females. So that either in Frankfort there were some causes of cancer operating to a much greater extent than in England and Wales, or, what he thought was very much more probable, the same degree of accuracy of diagnosis and certification had not been reached in England and Wales as in the German state. (2) He thought it was agreed on all sides that a considerable proportion of the registered increase in mortality from cancer was due to improved certification and diagnosis. The amount of that proportion might not be accurately known, but that some of the registered increase was due to that cause would be agreed on all sides. It was only a question of whether the residue of real increase was large or small, or non-existent. (3) Everyone would agree, furthermore, as to the desirability of finding the cause of the disease, with a view to its possible prevention. Although the origin of cancer was beyond the scope of the enquiry that evening, the various theories with regard to the supposed increase of cancer were not. With regard to the theory of improved nutrition, the lowest death rate of cancer in Mr. Teece's paper was in New South Wales, where the population ate more meat than in any other country in the world. Mr. King had pointed out that the statistics for New South Wales had not been properly corrected for age distribution, but even when this was done they were lower than England and Wales, although the consumption of meat per head of population was very much larger. Then Dr. Payne emphasized the importance of the great increase in cancer in the digestive organs, and alluded to that as confirming the idea that there was some special cause operating on the digestive organs. Taking the figures for Ireland (given on the appended table), it would be found that the increase of cancer of the stomach in 12 years had been 21 per-cent, whereas the increase in all forms of cancer had been 35 per-cent, which did not appear to indicate that any cause of cancer was operating more on the stomach than on other parts of the body. As a matter of fact, the stomach and the digestive organs generally had always been the chief seat of cancer. Taking the Irish figures, it would be seen that 26 per-cent of the total deaths from cancer were cancer of the stomach, or, if the liver was included, 38 per-cent, so that more than one-third of the total deaths from cancer in the entire country were due to cancer of the stomach and liver. That being so, it was evident that owing to improvement in diagnosis and certification, there was scope for very considerable increase. He had in his hands a very large number of certificates of death copied from entries in Brighton 10 to 13 years ago, and during the last three years. In the three years he was able to pick out 35 death certificates, a large proportion of which, in his opinion, were really due to cancer, although not one of them was entered as such. In the three earlier years there were 57, and in the latter three years only 35. Dr. Payne had challenged him to find a case in which there was any evidence of improved certification in the last 10 years, and there was one. If local irritation was the cause of cancer, a diminution in the death rate from cancer ought to be expected, owing to the more frequent and early operations than formerly, but, from what

Sir Thomas Smith had said, it was still an open question whether any marked decrease in the deaths from cancer could have resulted from that cause, and even if it had resulted from that cause, the scope for increase due to improved diagnosis and certification was still very large when the comparatively low figures in Ireland were compared with the very high figures of Frankfort and Brighton. The results of early operation and cure thus secured would be shown rather in a slackening of the rate of increase than in an actual cessation of that increase. The English figures, in his opinion, did show that slackening of increase. He had summarized the quinquennial periods from 1861 to 1865 onwards. In the first quinquennial period the rate of increase was 10 per-cent; in the next three, in each of them, it was 11 per-cent; in the fourth it was 15 per-cent, and in 1891 to 1895 it was 13 per-cent increase, and from 1896 to 1900, judging by the three years 1896 to 1898, it had gone down to only 10 per-cent. So that there was already a slackening in the increase of the death rate from cancer in England. Then he drew attention in the next place to the Brighton statistics, which were got at without any *arrière pensée*. They referred to the three years 1887 to 1889, and 1897 to 1899, and it would be seen that in the former period the death rate from cancer in the Brighton population, which was roughly about 120,000, was '86 per thousand, while in the more recent period it was '83. That was not owing to the fact that fewer old people lived in Brighton than formerly. As a matter of fact, the number was annually increasing with the population. Those figures were confirmed by the Eastbourne experience, which also showed a lessening of the death rate from cancer. Why should Brighton and Eastbourne show a decrease when the whole country was showing an increase? The reason was not far to seek. The Brighton doctors undoubtedly certified as a whole much more accurately than the doctors of the average of the whole country. They were of a higher class; they had to attend rich residents and visitors, and there was no doubt that the average standard of practice and certification was very much higher than for the whole of the country. Furthermore, the number of persons treated in hospitals in Brighton was large in proportion to the total population. Brighton consisted of very rich people and very poor people; the very rich people being treated by some of the best doctors in the country, while the very poor were treated in hospitals; and in hospital, if the cases proved fatal, autopsies were held, and a more accurate description of the death given. With regard to the question of autopsies, he quoted a letter from Sir Samuel Wilks, the ex-President of the Royal College of Physicians, in which he said: "There can be no doubt that the better diagnosis has led to the knowledge of cancer formerly not recognized. From my own experience, the custom of having *post-mortem* examinations in hospitals has added to the apparent increase, and in some cases has added altogether new facts. For example, cancer of the lung is not very common (which, as a matter of fact, is cancer round the bronchi going into the lung). I never saw this diagnosis unless there were external enlargements of glands—they were all called phthisis. Then mediastinal growths—killed by pressure on neighbouring parts—often not correctly diagnosed, and if suspected the term *growth* rather than cancer would be used. Since *post-mortem* times these would be

added. Probably some tumours of brain are cancerous, even primary. Before the *post-mortem* period these would not have been registered, and, if so, simply as tumour. Then the abdominal cases are numberless where the *post-mortem* alone showed the nature. In chronic fatal jaundice, most medical men would diagnose a growth involving the ducts; very frequently, however, no growth or tumour is to be felt, and therefore they would not certify cancer without further proof. I write this in consequence of your attributing the increased number reported to improved diagnosis. I wish to add that the habit of making *post-mortems* in all the hospitals often constitutes the diagnosis, and this is sufficient to account for a great increase. When I went to Guy's, a *post-mortem* was made only in exceptional cases, and with express leave from the friends; now it is the habit. Perhaps nomenclature may have some slight influence." He also quoted from a letter written by Sir William Gairdner, who is recognized as the head of the medical profession in Scotland, in which Sir William Gairdner referred to Dr. Howden's results with regard to the occurrence of cancer in the Montrose Asylum, and said: "The numbers were small, but they seemed to carry at least thus far—that in a public institution, where no possible bias could be imagined, pro or con, as regards the admission of cancer cases, and where the deaths had for thirty years or more been recorded on a definite plan, with *post-mortem* examinations tabulating all the lesions discovered in all the internal organs, and indexing them all without any preconceptions as to this or any other subject, there was absolutely no appreciable difference between the first half and the last half of the same series as to the proportional occurrence of cancer." He wished to draw attention to the fact that it was not necessary to assume better diagnosis, and that a more accurate certificate did not necessarily imply better diagnosis. Many doctors would not trouble to write a complete certificate. They were not paid for the certificates, and the medical profession was one which had to do an enormous amount of work for nothing. It was a duty the State imposed on them, and it was expected to be done without any payment; and it was, therefore, no wonder that an exact statement was not obtained in every case. Another thing leading to incomplete statements was the fact that the certificate was handed to the nearest relatives, who did not like a cancer certificate; and there was no doubt that where death was reported as due to ulcer of the stomach it was often done to soothe the feelings of the relatives. He maintained that it was premature to speak of an increase of cancer until it could be shown by examination of the death certificates of a given community that there were no omissions of cancer deaths in them. If in the two periods he had referred to he had added the thirty-five deaths to the death rate of cancer in Brighton, it would have increased from '83 to '97, or 17 per-cent. It was premature to compare two communities and to say that in one of them there was a greater increase in cancer than in the other unless one was certain there was the same amount of accuracy of certification in the two communities. The table of comparison between Ireland and Brighton was a very good illustration of that. In Ireland there was very defective certification, while in Brighton there was relatively good certification, and one of them showed an extraordinary increase of cancer, while the other showed it to be

stationary. Then, again, the assumption of increase of cancer would, by parity of reasoning, imply the increase in other causes of death. Taking digestive diseases, and comparing 1861-65 with 1871-75, there was a decrease of 7 per-cent; and then in 1891-95, ten years later, there was an increase of 27 per-cent, evidently due to the varying fashion in certificates. In diseases of the nervous system there was an increase of 84 per-cent, and in diseases of the circulatory system an increase of 68 per-cent. Nobody believed there had been an increase in those diseases, at any rate, to that extent; and he maintained that the same line of argument applied exactly to cancer, the diagnosis of which, in its internal and common forms, was difficult, and the certification of which was less accurate than the diagnosis. Under old age there was a decline of 21 per-cent, and in ill-defined causes a decline of 62 per-cent, all of which would tend to add to the results of cancer, as well as other causes. In fact, he might quote the Registrar-General, and apply his remarks to cancer as well as to those other obscure diseases which apparently showed an increase. The Registrar-General said: "To be without trustworthy means of comparison involves an evil, but to ignore the differences and to deal with records as thoroughly reliable would be still worse; for it is far better to be without statistics at all than to be misled by false ones." Lastly, there was a converging line of evidence showing that the statistics indicating increased cancer could not be trusted. Mr. King had summarized the evidence from the joint paper written by Mr. King and himself, and he need not go into that again. There was the evidence of Frankfort, and although Dr. Payne objected to the figures, especially the male figures, as being too small a basis, he must remind him that they were not given alone, but were part of a whole, and were simply one small converging line among other lines of evidence, and that it was not inadmissible to state them, even although they were based upon a small number of facts. With regard to the mortality experience of the Mutual Life Assurance Company of New York, Mr. Teece stated that it appeared to him that the isolated example given in the paper could scarcely be held to negative the teaching of the other statistics quoted by him. His (Dr. Newsholme's) impression was that it did partially negative it. One exception like that, if well authenticated, did not prove the rule, but, to a large extent, disproved it. In communities like Brighton and Eastbourne, and in the insurance experience of the Mutual of New York, one had communities in which the same supposed causes of increase had operated as in the general population, and yet the same increase did not occur. That being so, one was driven back on the conclusion that the increase in other communities was probably only apparent, and was due to a more accurate statement of causes of death. The hospital statistics given by Dr. Payne were, he thought, fallacious. If the proportion of admissions for cancer of the stomach, for instance, was stated to admissions for other causes, one had not all the necessary data before one. Cancer of the stomach was a form of cancer for which no operation was usually practicable.

Dr. PAYNE said he did not say of the stomach but of digestive organs altogether.

Dr. NEWSHOLME said that in the majority of cases of cancer of the digestive organs no operation was possible. The proportion of

that form of cancer might have increased in the St. Thomas's statistics, because in private practice a much larger proportion of operations for cancer were performed now than formerly, and, in the next place, there were a considerable number of special cancer hospitals which drew to themselves special forms of cancer for which operations were practicable, and those two considerations, amongst others, vitiated any conclusion that might be drawn from the proportion of cancer of the digestive organs to the total cancer cases of the St. Thomas's Hospital statistics.

TABLE.

Registered Deaths from Cancer (Malignant Disease).

Seat of Primary Disease	IRELAND				BRIGHTON			
	Three Years 1887-89		Three Years 1897-99		Three Years 1889-91		Three Years 1898-1900	
	M.	F.	M.	F.	M.	F.	M.	F.
Head, Face, Eye, Orbit, Nose,								
Ear	215	209	260	227	3	4	4	3
Jaws	93	35	146	45	6	...	2	1
Mouth, Tongue, Lips	304	57	423	85	8	3	7	2
Neck, Throat, Tonsils, Larynx	216	100	292	104	7	8	5	4
Axilla, Arm, Hand	29	22	58	56	...	...	1	2
Lung, Chest, Mediastinum . .	*		14	9	1.	2	2	2
(Esophagus	*		56	42	9	1	11	3
Breast	11	738	24	835	...	44	...	44
Abdomen	*		77	128	1	11	3	6
Stomach and Pylorus	955	769	1,152	925	16	15	22	17
Liver and Gall Bladder . . .	215	301	415	521	10	15	16	25
Pancreas	*		21	11	3	1	2	4
Peritoneum, Mesentery . . .	*		13	33	...	5	3	7
Intestines (excluding Rectum)	79	103	141	163	4	7	10	9
Rectum	101	93	215	147	5	14	15	15
Ovary	*		...	28	...	8	...	5
Uterus . . . . .	...	484	...	547	...	44	...	43
Vagina and Vulva	*		...	28	...	...	...	2
Penis	*		19	...	...	...	...	...
Pelvis, Kidney, Bladder, Pros-								
tate, Urethra	*		54	31	9	4	2	6
Testes, Scrotum	*		15	...	2	...	2	...
Groin, Leg, Foot	106	104	102	141	1	2	3	...
Other Specified Parts	195	140	103	91	...	...	...	...
Parts Unspecified	258	294	44	97	9	16	6	9
Total	2,777	3,449	3,644	4,294	94	204	116	209
Annual Death rate per 1,000 } of Estimated Population†)	.43		.58		.86‡		.83	
Increase	35 per-cent				None			

* Deaths from Cancer of this part of body not separately tabulated.

† The population of Ireland in 1891 was 4,681,248; the official estimate for 1898 was 4,543,773. The population of Brighton in 1891 was 115,606; the official estimate for 1899 was 123,227.

‡ The mean annual death rate from Cancer in Brighton in 1851-70 was .30; in 1871-80 it was .75, and in 1881-90 it was .87 per 1,000.

Mr. H. W. MANLY thought the Institute was to be congratulated upon having had such an interesting discussion upon a subject which only concerned them indirectly, and had to thank its medical friends for giving so much information on the matter. Fortunately for him, Dr. Newsholme had gone so carefully over the subject, and discussed so effectively what had been said that evening, that there was very little left for him to say. He might, however, state how it presented itself to his mind as an actuary. First, there was evidence of an increase in the number of registered cases of deaths from cancer; secondly, that increase was greater than the increase of the population; thirdly, it was admitted, he thought, generally, that there had been a great improvement in the diagnosis of that disease. Then came a question, whether the improvement in the diagnosis had caused the apparent increase in deaths from cancer. But, although these statistics tended to show that there had been a great increase of deaths from cancer, there was no doubt that there had been a considerable decrease during the same period in the rate of mortality generally. Where, then had that decrease come in? He should be told, no doubt, that there had been a great improvement in the treatment of zymotic diseases, and so on, but still there must have been a tremendous improvement to have admitted of an extension of the deaths from cancer. Owing to the great improvement in diagnosis and registration, cases which formerly would have been classified under other diseases were now correctly attributed to cancer; and did not these transfers make up the difference in the numbers? Dr. Newsholme had shown that there were many cases registered in Brighton of deaths from some other disease than cancer, but when they came to be examined there was no doubt they ought to have been registered as cancer; and he would suggest that medical men should draw up a list of the possible causes which might have been given before the better diagnosis or better registration, and see whether there had not been a very considerable reduction in the numbers now returned under those heads. In discussing a question like this, one was inclined to speak from personal knowledge. There was one case which made a great impression upon him, of a man who suffered for some time from what was called indigestion, and that indigestion grew to such an extent that he could not take any solid food. He thought then it was quite time to get insured, and he insured his life for £10,000, being passed as a first-class life. He paid one premium, and the indigestion got worse, and he went to many of the first physicians in London, who could not tell him what was the matter. At last an exploratory operation was suggested, and when the operation was performed they found a portion of his intestines deeply involved in cancer. Now he could not imagine what his death would have been described as arising from if the operation had not been performed. Here was a man who could afford to have the very best advice who suffered from cancer in an inaccessible part, and it was only by the great improvement in surgery that the cause was discovered. Some years ago medical men would have hesitated to perform such an operation, and some other name would have been given as the cause of death; and he imagined that there had been

many such cases. With regard to the question of registration and diagnosis, he referred to a paper by Sir John Sibbald, read before the Royal Society of Edinburgh, upon suicides in Scotland, with reference to a statement drawn from the Registrar-General's Returns, that suicides in Scotland had greatly increased. In the paper Sir John Sibbald pointed out that that really was not the case. He said that the belief that suicide necessarily involved disgrace had greatly diminished since suicide had been recognized to be in a large proportion of cases the result of mental disease, and in consequence of that change of opinion efforts to conceal the occurrence of suicide had correspondingly decreased. That was another evidence in favour of what Dr. Newsholme had pointed out, that there had been an opinion that cancer was not a respectable disease to die from, and therefore great efforts had been made on behalf of the family to conceal the fact that it was cancer, other names being given for the cause of death. That now was not so much the case.

A vote of thanks was unanimously accorded to the author for his paper.

"On the Alleged Increase of Cancer." By GEORGE KING, F.I.A., F.F.A., and ARTHUR NEWSHOLME, M.D., F.R.C.P., *Medical Officer of Health of Brighton*.—Read before the Royal Society 4 May 1893.

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DURING the last few years the minds of medical men and of the general public have been exercised over the rapid and striking increase in the mortality from cancer, as shown by the statistics contained in the Registrar-General's Annual Reports. The following table, taken from these reports, shows how great this increase in registered mortality has been. The registered death-rate of males from this disease was 2·7 times, for females 2·0 times, and for both sexes together 2·2 times, as high in 1891 as in the average for the decade 1851-60.

TABLE A.—*Mortality from Cancer in England and Wales per Million Living at all Ages.*

	1851-60	1861-70	1871-80	1881	1882	1883	1884
Males .	195	244	315	364	364	381	405
Females .	534	523	622	668	692	702	707
Persons .	317	387	473	520	534	549	563
	1885	1886	1887	1888	1889	1890	1891
Males .	411	424	456	450	488	512	518
Females .	713	733	748	761	790	830	855
Persons .	572	572	615	621	656	676	692

That cancer has really increased in this country appears to be now generally assumed in medical circles.

Sir Spencer Wells, in his Morton Lecture (November 1888), gives the Registrar-General's figures, showing that the mortality from cancer had increased from 488 per million of the population in 1877 to 615 per million in 1887 in England and Wales, and from 350 per million in 1877 to 430 per million in 1887 in Ireland, as proof of this increase; and further quotes the statement of Dr. Fordyce Barker, that the mortality from cancer in the city of New York had risen from 400 per million in 1875 to 530 per million in 1885.

The attitude taken by the Registrar-General's Department has become somewhat modified of late years, doubts having been formerly cast on the reality of the increase, whereas now the generally received medical opinion appears to have been adopted. Thus, Dr. Ogle [p. xiv, Supplement to the 45th Annual Report (1882) of the Registrar-General] points out that the deaths ascribed to *malignant disease* in the decennium 1851-60 amounted to 317 annually per million persons living; in the next decennium it had risen to 387; and in the decennium 1871-80 to 473; but adds: "there can be very little doubt that a considerable part in this apparent increase is simply due to improved diagnosis and more careful statement of cause on the part of the medical men."

In the 46th Annual Report (1883) of the Registrar-General (p. xviii), are the following remarks, bearing on the same point: "How much, if any, of this increase (in cancer) was real cannot be stated with any accuracy; but that some part of the apparent increase was only apparent, and due to improved diagnosis and more careful statement of cause, can, as we stated in previous reports, scarcely be doubted. Year by year the number of deaths ascribed to 'abdominal disease' and other imperfectly stated causes has been undergoing diminution, and there has been, of course, a corresponding addition to the mortality under the more definite headings. Moreover, the increase of mortality from cancer has been considerably greater in the male than in the female sex. Now, were the rise not only apparent but real, there would seem to be no reason why males should have suffered more than females; whereas the difference is readily intelligible on the hypothesis that the rise was, at any rate in great measure, really due to improved diagnosis. For the cancerous affections of males are in a much larger proportion internal or inaccessible than are those of females, and consequently are more difficult of recognition, so that any improvement in medical diagnosis would add more to the male than to the female figures."

In the 52nd Annual Report (1889) of the Registrar-General (p. xiii), attention is again drawn to the increasing mortality from cancer, which now amounted to 656 per million persons living, "showing a further increase upon the ever-growing rates previously recorded." Then follow these remarks (the italics are ours):—

"Some of the increase is most certainly attributable to increased accuracy in statement of cause, and to the system introduced some years back into this office of writing for further information in cases where some vague cause, such as 'tumour', had been given as the

"cause of death in the original certificate; a system which added, for instance, in the year 1889 no less than 421 deaths to the heading 'Cancer.' Nevertheless, in face of the constant and great growth of mortality under this heading, and the expressed belief of medical practitioners specially engaged in dealing with this class of diseases that they are becoming more and more common, *it seems scarcely possible to maintain the optimistic view that the whole of the apparent increase can be thus explained; and it must be admitted, as at any rate highly probable, that a real increase is taking place in the frequency of these malignant affections.*"

It is evident, therefore, that although the view that the increase in cancer was chiefly, if not entirely, apparent, has, until recently, been held in the English General Register Office, it is now reluctantly accepted as a probable fact that cancer has really increased; and it must be admitted that the figures on which this conclusion is based, as shown in the preceding table, look, at first sight, to be overwhelming in the weight of their evidence.

A more careful investigation, however, shows that the ratios prepared in the usual manner from the returns of the Registrar-General at the best only approximately represent the truth, and that, in fact, they may even be very misleading. Cancer is, *par excellence*, a disease of mature life. In a population of 1,000,000 adult males, aged from 25 to 35, about 95 would die annually from cancer; while there would be about 2,530 deaths among 1,000,000 males from 55 to 65, and 4,405 deaths in 1,000,000 males aged from 65 to 75. Therefore, to take the deaths from cancer at all ages in a community, and to compare them with the total population in order to arrive at the cancer death-rate, may introduce an error sufficiently serious to vitiate the results. If there be a larger proportion of lives, below, say, 50 years of age, the fraction formed by dividing the number of deaths from cancer by the total population will give an unduly small ratio; whereas, if the lives above 50 years of age be in excess, the ratio will be unduly large. Now the age distribution of one district may differ materially from that of another, and the age distribution of the males in a community may differ from that of the females, and the age distribution of the same district may possibly differ at different periods. That this consideration is of great importance is shown by Table I (Appendix), which gives the age distribution per million of population of each sex according to the census of 1881 in the several divisions of the United Kingdom.

It will be noticed that the average age of females in England and Scotland is higher than that of males, while the converse is the case in Ireland; and that the average age of the population in Ireland is much higher than in either England or Scotland. Consequently, the death-rates from cancer given by the Registrar-Generals of the three divisions of the United Kingdom in their Annual Reports are unduly unfavourable to the female sex in Great Britain and to the male sex in Ireland; and, similarly, the death-rate from cancer in Ireland is exaggerated as compared with that of the sister kingdom.

To rectify this error it is necessary to assume a standard of age distribution, to be applied to each set of statistics examined. It is not of importance what standard is selected, because, all the

observations being treated alike, the comparisons instituted between them will be entirely trustworthy. It is desirable, however, to adopt a standard which is not purely arbitrary, and in the following investigations we have therefore used that given by the "English Life Table, No. 3, Persons", as the most suitable. This represents a stationary population unaffected by changes in the birth-rate or by migrations; and, although no existing community conforms to it, yet, for purposes of comparison of one community with another, it answers every purpose. The following is the age distribution according to this standard:—

TABLE B.—*Age Distribution according to the English Life Table, No. 3, Persons.*

Ages.	Population.
25-35	260,259
35-45	232,106
45-55	199,912
55-65	158,812
65-75	102,196
75 and upwards	46,715
	<hr/> 1,000,000

These considerations showing that a source of fallacy lurks in the rates of mortality usually quoted (especially when one country is compared with another), and that this fallacy specially affects the question of cancer, we came to the conclusion that it was desirable to investigate the alleged increase of cancer altogether afresh, and to avail ourselves in doing so of all the materials that could be turned to good account.

In order to be useful, the materials must extend over a long period of time, and must be presented in such form that, at any rate for several intervals of years, the deaths from cancer and the population may be grouped according to age and sex.

The records of life assurance offices of old standing might throw much light upon the subject, and doubtless if access could be had to them, and if the experience were collated in a suitable manner, an immense amount of most valuable information would be obtained. Unfortunately these sources, with one conspicuous exception, are not available. This exception is the Scottish Widows' Fund Life Assurance Society. For many years that institution has been accustomed at each septennial investigation to prepare a very complete statement of its mortality experience, distinguishing the deaths according to age and according to the causes of death, and at the same time giving the number of lives at risk in each interval of age. Through the courtesy of the manager, Mr. A. H. Turnbull, these statistics have been placed at our disposal, and he has also kindly given us the figures for the four years 1888-91, which have elapsed since the last septennial valuation, thus enabling us to bring the investigation approximately up to date.

So far as we know, the British Empire Mutual is the only other office which has abstracted its experience in such a form as in the present connection could be of any service. The experience of that Society, distinguishing diseases, was published for the two periods

1847-72 and 1872-78, and the following figures are extracted from the reports:—

TABLE C.—*Experience of the British Empire Mutual Life Office.*

Ages of Lives	PERIOD 1847-72		PERIOD 1873-78	
	Lives at Risk	Deaths from Cancer	Lives at Risk	Deaths from Cancer
25-35	42,448	1	13,151	1
35-45	61,136	8	18,397	3
45-55	43,887	18	19,332	6
55-65	17,410	12	12,825	15
65-75	3,973	4	4,225	9
75 & over	556	0	646	2
Total	169,410	43	68,576	36

Unfortunately these facts are so scanty as not to afford trustworthy averages, and we have not seen our way to make further use of them. They show an apparent increase of about 50 per cent in the death-rate from cancer in the period 1873-78 over 1847-72; but it must be remembered that, the office having been founded only in 1847, the lives assured had, in the earlier of the two periods, on the average much more recently passed the medical examination than in the later period. Cancer being a disease of comparatively slow development, this is a disturbing factor the effects of which it is impossible to measure. A life office must have been established for many years, and must for a long period have been transacting a business approximately uniform, before it is safe to base any conclusions upon its experience of such a disease as cancer.

The Scottish Amicable Life Assurance Society and the Clergy Mutual Life Office have each published their experience, giving the deaths from cancer and the lives at risk according to age; and in the collective experience of Thirty American Offices, published in 1881, similar particulars are given; but in each of these cases only one period of time is investigated, and therefore, for present purposes, their figures cannot be utilized. On two occasions the Australian Mutual Provident Society, which is the largest life office in the British dominions, has investigated its mortality experience, and on each occasion has tabulated its cancer figures; but, for various reasons which we need not particularize, this information could not be successfully utilized.

The returns of the Scottish Widows' Fund, above mentioned, extend over four septennia and a broken period of four years, making a total period of thirty-two years during which it is possible to minutely investigate the causes and progressive rates of mortality. The figures, so far as they bear upon the present inquiry, are given in Table II in the Appendix.

The Scottish Widows' Fund statistics being only available in the

form given in Table II, we proceeded to extract the Registrar-General's data for the same periods and in the same form, in order that trustworthy comparisons might be instituted; and we also treated in precisely the same way the valuable statistics of Frankfort-on-the-Main, to be described more minutely later on.

For England, Scotland, and Ireland respectively, the census enumerations of 1861, 1871, and 1881 were available for both males and females, the populations being classified in the same age periods as in the data supplied by the Scottish Widows' Fund. We had also the total populations, both male and female, enumerated in 1891, but information as to the age distribution of these populations had not hitherto been published. It was therefore necessary to assume that the age distribution in 1891 was the same as in 1881. A source of inaccuracy has been thus introduced, but its magnitude cannot be serious.* From the figures in the four census enumerations, the number of males and females respectively living in the middle of the years 1861, 1871, 1881, and 1891, were calculated for each age period 25-35, 35-45, 45-55, 55-65, 65-75, and 75 and over; and from these figures again the numbers living in each age group in the middle of each year from 1860 to 1891 inclusive were worked out. These were then classed into septennial periods, as with the Scottish Widows' Fund, with a broken period at the end. In this way was obtained with great accuracy the population in age groups in each division of the United Kingdom, passing through a year of life in each of the septennia under review. The deaths from cancer, arranged according to age, are given in the annual returns of the Registrar-General, and these were extracted and summed for the septennial periods. The annual returns for England and Wales and for Ireland came down to 1890 inclusive, but for Scotland the last year available was 1889, and the several observations were therefore closed at these points respectively. In the case of Ireland, we could not obtain the deaths from cancer prior to 1864, and we have therefore been limited to the three years 1864-66 for Ireland, instead of the seven years 1860-66.

For purpose of reference, and in case other inquirers desire further to investigate our figures, we give them in Tables II to V in the Appendix, arranged as above described.

From the figures in Tables II to V may be at once obtained the death-rates from cancer for each period of years, and for each age interval. As the resulting rates are necessary to the subsequent calculations, they are given in Tables VI to IX in detail, and are expressed as rates per million, in order to reduce the number of decimal places. The numbers, as might have been expected, run irregularly, but, on account of the method of grouping of the figures later on, this irregularity is not of any practical importance.

The rates of mortality given in Tables VI to IX, notwithstanding the considerable numbers on which they are based, do not run with sufficient regularity to disclose the general law by which they are

* Owing to the steady fall in the birth-rate between 1881 and 1891, the average age of the population is probably somewhat higher at the latter date. This would tend to slightly exaggerate the apparent increase in the death-rate from cancer.

governed; and, even though they did run regularly, it would not be easy to discover from them that law. Moreover, it is not the object of the present inquiry to ascertain the liability to cancer at different ages, but to discover whether cancer is on the increase or not in the community generally. It is therefore necessary so to group the figures that the total cancer experienced at all ages in any particular period of years may be compared with the total cancer experienced in any other period. If we take the rates of mortality given in Tables VI to IX and multiply them into the populations of Table B, we shall have the desired results. The sum of the products for any particular period of years will give the number of deaths from cancer per annum among 1,000,000 persons aged 25 and upwards. Then by comparing the sum for, say, the period 1860-66 with that for the period 1881-87, we can ascertain in which direction the apparent death-rate from cancer is progressing. It will be observed also that by pursuing this course the observations for all the different localities and all the different periods of years are reduced to one common standard, and the errors are eliminated which would arise from variations in the age distribution of the populations. Tables X and XI display these results in their final form, the ratios for ages under 55 and over 55 respectively, as well as for all ages, being given in them. Some persons may be glad to be able to investigate the matter for these two great periods of life, although we do not propose to include this branch of the subject in our inquiry.

In Tables X and XI the death-rates have been corrected for age distribution, and a single illustration will indicate how important is this correction, and how serious an error may result from its omission. Taking from Tables III and V the total population at risk for all ages, and the total deaths from cancer, and dividing the second by the first for each period of years for England and Ireland respectively, we shall have the death-rates from cancer in the form usually presented by the Registrar-General. They are given in the following table, and alongside them are placed the corrected rates from Table X.

TABLE D.—*Comparison of Corrected and Uncorrected Cancer Death-Rates.*

Period	NOT CORRECTED		CORRECTED	
	England	Ireland	England	Ireland
1860-66	498	553	625	614
1867-73	597	627	747	661
1874-80	719	680	911	699
1881-87	902	807	1,152	824
1888-90	1,091	894	1,393	912

It will be observed that by the uncorrected figures Ireland stands a little above England for the first two periods, and a little below it for the other three, but that no very great difference appears between

the rates for the two countries. The corrected figures, however, show that Ireland stands below England throughout, so that in the first two periods the position of the countries is reversed by the correction, and in the last three periods the difference in favour of Ireland is very great indeed. It is evident that the ordinary method of presenting the statistics exaggerates the rate of cancer in Ireland as compared with England, a result which, as already explained, might have been expected, owing to the age distribution of the populations of the two countries.

Much light may be thrown on the subject by a careful analysis of Tables X and XI. It is, however, difficult from arrays of figures to ascertain their exact teaching, and it is, therefore, desirable to aid the mind by translating the figures into a graphic form. In Tables X and XI the rates of mortality from cancer are given for five periods of years, and from them the rates may be obtained for each individual year. If these subdivided results be then plotted out in curves, the forms and directions of the curves will show at a glance, far more conclusively than could the most elaborate examination of tabulated figures, the nature of the progression of the rates of mortality.

This distribution into individual years might be accomplished by skillful application of analytical processes; but the method would be very difficult on account of the nature of the material available, and the results could scarcely fail to be unsatisfactory and untrustworthy. The end can be much more satisfactorily attained by a modification of the late Joshua Milne's graphical method of constructing mortality tables, which has been fully described, and of which the beautiful accuracy has been demonstrated and illustrated by one of us (G. K.) in two papers in the *Journal of the Institute of Actuaries*, vol. xxiv and vol. xxx. As showing the application of the method to the present inquiry, the accompanying diagram, No. 1, relating to England and Wales, is submitted, of which a very few words of explanation will suffice. Along the abscissa axis are marked off equal lengths to represent each of the periods of seven years under review, with a portion of proportionate length for the three years 1888-90; and along the ordinate axis the rates of mortality per million are marked off. Rectangles are then erected, the areas of which are to represent the number of deaths from cancer in each of the septennial periods. Thus the area of the rectangle for the septennium 1860-66 is 4,375 for males, as its base is 7 and its altitude 625. Similarly for the other rectangles.

Through the tops of the rectangles must then be drawn a continuous curve in such a way that the area cut off is exactly equal to the area added. The length of the ordinate of the curve which is central to any particular year will then give the deaths from cancer in that year; and the accuracy of the drawing of the curve will be proved, if there be no sudden change of direction, and if the sum of the numbers for the seven years of a septennium is equal to the area of the rectangle for that septennium. Diagram No. 1 shows the curves for England and Wales, that for males being in an unbroken line, and that for females in a dotted line. Similar curves were prepared for all the observations so far discussed, and they are collected in Diagram

No. 3, so that they may be easily compared. The curves for males are in continuous lines, while those for females are broken, and that for the Scottish Widows' Fund is marked by crosses.

The only curve which proved at all intractable was that for the Scottish Widows' Fund in its earlier portion. It will be seen from

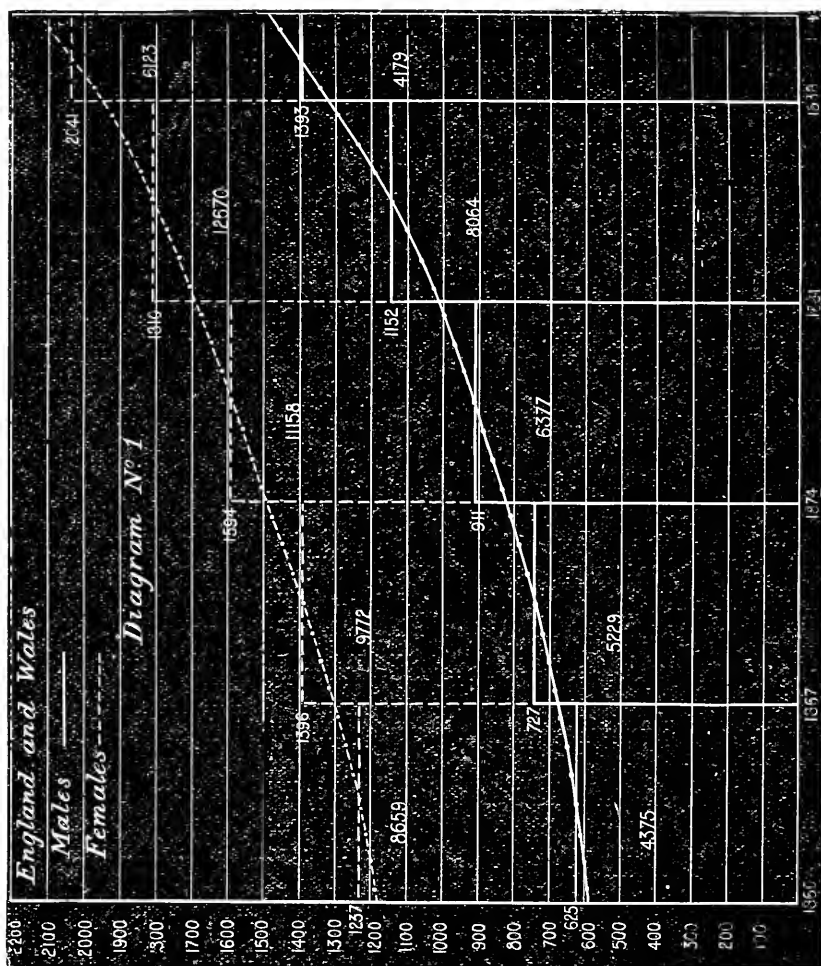
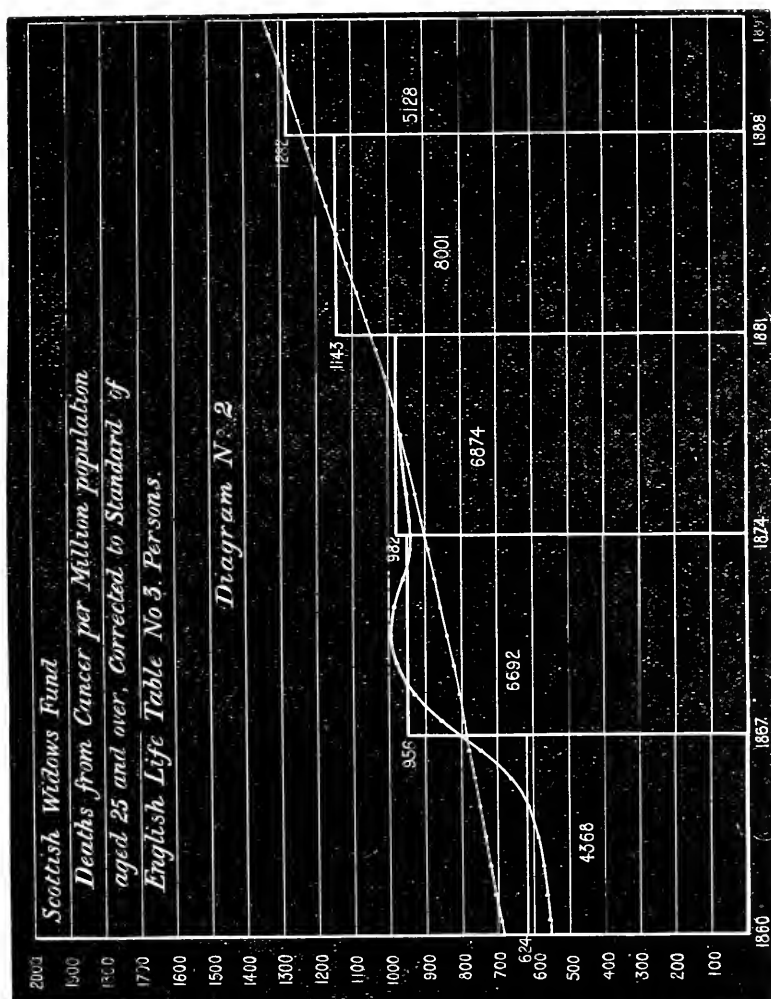


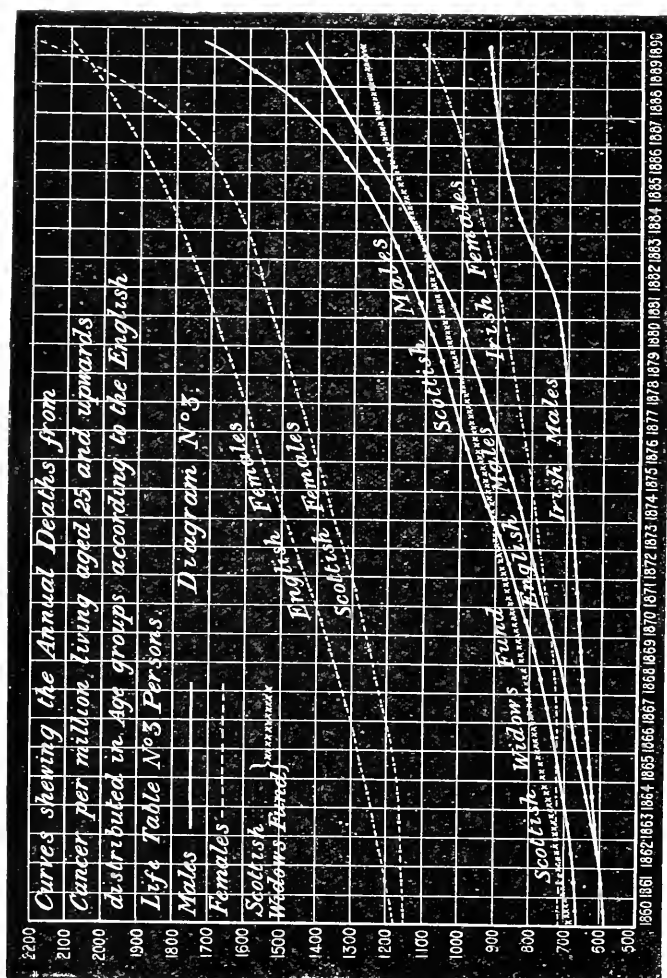
Table X that the death-rate from cancer in the first septennium was very light, while in the second it was comparatively heavy, very nearly equal to that in the third, and that the rates in the third, fourth, and fifth exhibit an almost uniform upward progression. These peculiarities are better seen by the help of Diagram No. 2, where the deaths are represented by the rectangles. The second and

third rectangles being of nearly the same altitude, while the first is much lower, and the fourth considerably higher, there is indication of a rapid rise in the curve between the first and second periods and of a slight fall between the second and the third, and effect has been given to this in the undulating curve shown in the diagram. The



most unpractised eye will, however, at once perceive that the undulating line cannot represent the real law of the curve, and more especially so when the other six curves are examined (Diagram 3). Except for the one bend in the Scottish Widows' Fund curve, they all partake of one character, and the conclusion is forced upon us

that the twist in the Scottish Widows' Fund curve is abnormal, and that it must be removed if we are to arrive at the true teaching of the facts. The data are given in septennial periods, and the shape of the figure suggests that were it possible to rearrange them into, say, quinquennial periods, the abnormality would disappear. The



abnormality is introduced by insisting on the rule that the area of each portion of the curve must be exactly equal to the area of its corresponding rectangle, a rule which is to a certain extent arbitrary. Where, as in the case of the Scottish Widows' Fund experience, the original facts are few, and insufficient when grouped into short periods to form trustworthy averages, it is better to enlarge the rule, and to

redistribute the deaths slightly as between the adjacent periods, while still arranging that the curve shall in general outline follow the summits of the rectangles, and that the area of the curve shall exactly equal the areas of the rectangles in the aggregate. In Diagram No. 2 the correction of the curve on these principles is shown, and it is this corrected curve which is repeated in Diagram No. 3. How slight the correction really is becomes apparent when we state that it is equivalent to the transfer of only seven deaths in the Scottish Widows' Society from the second to the first septennium, and of one death from the third to the second septennium. Where the data are so scanty such slight adjustments are unavoidable. It may be added, however, that the general deductions to be drawn from the forms of the curves are the same whether we adopt the original or the corrected curve of the Scottish Widows' Fund.

In Table XII the distributed rates of mortality, as derived from the curves, are given for each of the seven sets of observations so far considered.

We are now in a position to examine more attentively the nature of the seven curves, and to attempt to derive from them the lessons which they are capable of conveying.

The *Irish* curves are the lowest of all, and are consistent with each other. In each of them there is a moderate upward gradient from the beginning to the end of the observations.

The *English* curves for males and females are far apart, the female mortality from cancer being very heavy. The two curves are, however, consistent with each other. They both show a decided and slightly increasing gradient from beginning to finish.

The *Scottish* curves are much nearer each other than the English, the males in Scotland having a higher apparent mortality from cancer than in England, and the females having one lower. The gradient in the Scottish curves is much the same as in the English, except that for the last year or two the rise is more rapid. The experience for the last period is for two years only in Scotland, while for England and Ireland it extends over three years, and this may account for the difference. Probably for this reason the curves at the end are more to be depended on for England and Ireland than for Scotland.

The correction for age distribution which we have introduced brings out the fact that Ireland seems to enjoy a great comparative immunity from cancer. Probably deficient accuracy in diagnosis and certification may account for much, if not all, of this difference. Ireland is a poor country, the majority of whose inhabitants cannot afford to pay much for medical attendance. The resulting deficient medical attendance would tend to produce defective diagnosis, and thus to lower the cancer curve. Probably also, owing to the poverty of the patients and consequently of the medical attendants, the average skill of the general practitioners over large tracts in Ireland is less than in Scotland and England, and this again would lead to defective diagnosis.

It is probable that in Scotland the general practitioner has been in the past better educated than in England, and this would cause the curves for the sexes to approximate, because in the female, cancer being more commonly accessible in position, is more easily diagnosed

than in the male, and improvement in diagnosis would raise the curve for males in greater proportion than that for females.

This argument is, however, scarcely consistent with the fact that the curve for English females is the highest of the seven. It appears therefore probable that, apart from diagnosis, there is some cause in English female life more favourable to cancer than among Scottish women.

The Scottish Widows' Fund curve has the easiest gradient of all, and this seems strongly to point in the direction so frequently indicated by the Registrar-General, that the apparent increase of cancer in the community is due to increased accuracy in diagnosis and certification. The policyholders in the Scottish Widows' Office are insured on the average for substantial sums, and are, therefore, presumably well-to-do, and able to secure, on the whole, better medical attendance than the mass of the people. The diagnosis throughout has, therefore, probably been good, as suggested by the fact that the curve begins comparatively high. But even among the most highly skilled members of the medical profession diagnosis has been improving, and therefore the Scottish Widows' Fund curve rises like the others. Among the class of practitioners attending assured lives there is not, however, the same scope for improvement in diagnosis and certification of death as in the profession as a whole, and the gradient of the Scottish Widows' Fund curve is consequently easy. This curve might have been expected to be below those for English and Scottish males, because, although there is a small admixture of females who suffer more severely from cancer than males, yet the lives are select. Persons with marked cancerous family histories are excluded. Cancer, moreover, is a disease whose development is usually gradual and slow, and may be preceded for several years by non-malignant disease of the part subsequently affected with cancer; hence, for two, or even three or four, years after an initial medical examination, cancer among insured lives should be comparatively rare. Notwithstanding these considerations, the Scottish Widows' Fund curve is above all the other curves for males at the commencement, though it falls below those for England and Scotland at the finish. This, as we have already remarked, points to good diagnosis on the part of the medical attendants of the assured lives, and to an improvement in diagnosis on the part of the medical profession generally during the last thirty years.

Another reason for thinking that the apparent increase in cancer is at any rate mostly due to improved diagnosis is derived from a comparison of the curves for males and females respectively. It will be noticed that the curves for females are always the higher, and that in each pair of curves the difference is practically constant throughout the entire period. Now, if there were a real increase of cancer, there is no sufficient ground for thinking that this would be confined to any one set of organs of the body, or would affect one sex more than another; and in such case the difference between the cancer in males and females would be a percentage of the total, and would increase at the same rate as the curves themselves rise, and consequently the curves for males and females would tend to widen their distance apart. This, however, is not so. In each of the three

pairs the curves for males and females do not diverge, but, if anything, tend to approximate.

It may be urged that, notwithstanding what has been said above, cancer may have increased more in certain parts of the body than in others, and that, although it has really increased in both sexes, it has increased in such greater proportion among males, that the curves for the two sexes remain parallel. This view, however, is contradicted by the Frankfort statistics, to be discussed presently, which confirm in a remarkable manner the conclusion we have drawn that it is only the cancer of organs common to both males and females which has apparently increased, while cancer of the special female organs, which is most easy of all to diagnose, has practically remained constant.

The chief weakness of the figures already given for cancer consists in (1) the absence of distinction between *carcinoma* and *sarcoma*, the two chief varieties of malignant disease, which are, however, pathologically distinct; and (2) the absence of statement of the part of the body primarily affected by the cancer.

An accurate statement of the site of the primary cancer in each case would enable us to ascertain whether the increase of cancer had been general, or chiefly in the cancer of inaccessible parts the diagnosis of which is comparatively difficult. Unfortunately, medical certificates of death commonly omit any statement of the organ affected by cancer, and comparisons founded on those cases in which the position is stated in successive years are open to the fallacy that the non-localized cancers may have been transferred in increasing numbers to the more definite headings as time goes on.

There are no statistics available in which an accurate distinction is made between carcinoma and sarcoma, and the general terms "cancer" or "malignant disease" must therefore be regarded as including these two forms of malignant new growths in unknown proportions. It may be added, moreover, that no such statistics would be trustworthy unless each death were followed by an autopsy and by a microscopical examination of the diseased parts.

The town of Frankfort-on-the-Main is the only one known to us which has for a long series of years kept an accurate record of deaths from all causes, in which deaths from cancer are classified according to the parts of the body primarily affected.* In the original the Frankfort figures are given in great detail, but we have summarized them somewhat. Thus, Table XIII shows both for males and females at all ages the total number of deaths from cancer of various parts of the body in the same year periods as we have adopted throughout this paper.

The subdivisions in Table XIII are still too minute, and the numbers consequently too small, for the purposes of useful investigation in the present connexion, and we therefore proceeded to group them, as shown in Table XIV, in three broad classes, which may be called "accessible cancer", comprising cancers of external parts of the body and other parts in which the nature of the disease is easily demonstrable during life by physical examination; "inaccessible cancer", comprising

* "Statistische Mittheilungen über den Civilstand der Stadt Frankfurt-am-Main (1860-1889)."

cancers of internal parts and other parts in which, as in the case of cancer of the bones, diagnosis is less easily made; and "cancer, position undefined," comprising simply the first line of Table XIII. In Table XIV only deaths at age 20 and over are included.

Under "Accessible cancer" we have included only the four headings Tongue, Mamma, Uterus, and Vagina, cancers of which are all capable of careful and exact diagnosis.

Under "Inaccessible cancer" come cancers primarily affecting any other parts of the body.

It will be seen from Table XIII that the great majority of cancers coming under this second head are of parts of the body in which the difficulties of diagnosis are great.

The classification cannot be regarded as perfect. Thus it may be pointed out that the first group embraces a large excess of women among whom it is shown by the Registrar-General's returns in Great Britain that the apparent increase in cancer has been in less ratio than among men. In the next place, it may be argued that we have placed under the "inaccessible" division cancer of certain parts that might be more appropriately described as accessible. The following are the doubtful cases here referred to:—

TABLE E.

Part affected	1860-1866	1867-1873	1874-1880	1881-1887
Cancer of pharynx . .	...	...	1	1
„ œsophagus . .	8	8	18	39
„ rectum . .	21	28	39	32
„ prostate and bladder	8	10	6	16
„ penis . .	...	...	1	1
„ larynx and trachea	1	...	1	5
„ thyroid . .	1	...	...	...
„ bone . .	2	2	6	6
Total . .	41	48	72	100

Of the cancers enumerated above, cancer of the pharynx, thyroid gland, larynx, trachea, and penis are most accessible, but their number is so small (twelve in all) that their transference to the "accessible" group would have no appreciable effect; and since, before the paper took its present shape, they had been included with other cancers in their appropriate physiological system, and a considerable amount of calculation had been based upon that classification, they have been allowed to remain in the "inaccessible" group.

Cancer of the prostate and bladder may be regarded as intermediate between the "accessible" and "inaccessible" groups, but as cancer of these organs appears to have increased in a smaller proportion than the population, the effect of introducing it into the "inaccessible" group is rather to diminish the already striking

difference which we shall show to exist between the increase in "accessible" and "inaccessible" cancer respectively.

Cancer of the œsophagus has, we think, been properly placed in the "inaccessible" group. The majority of cases of stricture of the œsophagus in persons over 50 are undoubtedly due to cancer, and yet certificates stating the cause of death at these ages as "stricture of œsophagus", without any definition of the cause of stricture, are still common. There can be no doubt that in the past they have been much more common, and that therefore cancer of the œsophagus is rightly placed in the class of "inaccessible" cancers which have been largely affected by improved diagnosis and certification of deaths.

Cancer of bone has also been placed in the same group. The number under this head is small, and, as the vertebræ and other inaccessible bones are a favourite seat of cancer of bone, the classification appears to us correct.

Cancer of the rectum is more accessible than that of other parts of the intestines, and we have, therefore, extracted it separately, in order to ascertain whether its increase is in the same ratio as that of cancer of the upper parts of the intestine. The result is as follows:—

TABLE F.—*Cancer of Rectum and other parts of Intestines in Septennial Periods.*

Period	Cancer of Rectum	Cancer of remaining parts of Intestines
1860-66	21	15
1867-73	25	19
1874-80	39	36
1881-87	32	47

Thus, while cancer of the rectum increased (in absolute amount and not relatively to the population*) 52.4 per-cent, cancer of the rest of the intestines increased 213.3 per-cent. It is evident, therefore, that by including cancer of the rectum in the group of "inaccessible" cancers we have further diminished the sharp contrast between "accessible" and "inaccessible" cancers.

In Table XIII we give the deaths from cancer in Frankfort during the period under review, grouped according to age and sex; and in the sub-headings, α , β and γ , in Table XIV, the same facts are classified as above described.

Census enumerations of the city of Frankfort have been taken at frequent but irregular intervals, and we have been able to avail ourselves of the returns for 1864, 1867, 1871, 1875, 1880, and 1885. From these we calculated the population in the middle of each year from 1860 to 1889 inclusive for both males and females, arranged according to age; and a summary of the results is given in Table XV.

* The population of Frankfort increased from an average of 53,550 in the years 1860-66 to an average of 92,500 in the years 1881-1887; i.e., it nearly doubled. Therefore the *rate* of mortality from cancer of the rectum really diminished.

On account of the military element which prevails on the Continent, there were some causes of disturbance, but, owing to the frequency of the censuses, these were not of much practical importance, and, moreover, they scarcely affected the ages which, in an inquiry into cancer, are principally concerned.

From the populations of Table XV and the deaths of Table XII the annual death-rates were calculated, corresponding to those in Tables VI-X, but it is scarcely necessary to reproduce them here. From these again were calculated the annual deaths from cancer in 1,000,000 living aged 25 and over, the population being as before distributed in age groups, according to the English Life Table No. 3, Persons, as shown in Table B. A very slight adjustment was required in consequence of the Frankfort statistics being prepared for the decades 20-30, 30-40, &c., and not for 25-35, 35-45, &c., as at home. The final results are given in Table XVI.

The first thing that strikes one in examining this Table is the marked prevalence of cancer in Frankfort as compared with the United Kingdom, and we have failed to discover any facts in explanation of this, unless it be the extremely careful certification for which that city is noted.

Nevertheless, the same general laws prevail as with all the other statistics available. Cancer preponderates greatly in the female sex, and, looking at the column relating to the total cancer, the progressive apparent increase for both sexes is observable. The Frankfort figures are, however, very instructive on account of the sub-division of which they are capable.

The cancer of undefined position does not show much sign of progressive change. No doubt on account of paucity of data, the numbers run irregularly, but from beginning to end of the thirty years under review there is no marked tendency to increase or decrease. This fact is of great importance, because, although in any one year there may be accidental fluctuations, yet, taken over such a long series of years, the figures become trustworthy. On the other hand, the rates of mortality from "inaccessible" cancer, both for males and females, steadily rise, though, perhaps, not quite so rapidly as in the United Kingdom. One very remarkable fact becomes apparent, namely, that males and females suffer almost equally from "inaccessible" cancer, the average for the thirty years being 1,641 for males and 1,640 for females. The excessive mortality from cancer of females is confined to "accessible" cancer, that is, practically to cancer of the female sexual organs.

The numbers relating to "accessible" cancer run somewhat irregularly, probably because of the paucity of data, among males there having been only 31 deaths in this category during the thirty years; but no well marked law of variation can be detected. There is, if anything, a tendency to decrease, at any rate as regards males, but the sequence of the numbers is not such that we could say with certainty whether or not that tendency would continue were the duration of the observations to be extended.

Taking a general view of the Frankfort figures, the one result of surpassing importance to be derived from them is that *in those parts of the body in which cancer is easily accessible and detected there*

has been no increase in the mortality from it between 1860 and 1889.

It may be mentioned that, in 1887, Dr. Grimshaw, the Registrar-General for Ireland, began to tabulate the deaths from cancer in Ireland, according to the primary seat of the disease, whenever this is given in the death certificate. The number of years as yet available does not allow of any valid deductions being drawn, and the great variation during the four available years under the head of cancer of unspecified parts causes a further difficulty in utilizing the figures.

In the 52nd Annual Report (1889) of the Registrar-General for England, the subject of the part of the body affected by cancer is also discussed, and in the words of the Registrar-General, "a sufficiently large sample of those cases of cancer in which the seat of disease is more or less clearly specified" is taken out to warrant the assumption that "such samples fairly represent the bulk" (p. 15). This method, however, does not appear to us to furnish trustworthy results, and we only refer to it here in passing.

To summarize, the conclusions arrived at from the whole investigation are as follows:—

1. Males and females suffer equally from cancer in those parts of the body common to man and woman, the greater prevalence of cancer among females being due entirely to cancer of the sexual organs, viz., the mamma, ovaries, uterus, and vagina. This is shown by the Frankfort statistics, and may not unreasonably be accepted as a probable general law, seeing that in other respects, where comparison is possible, the Frankfort statistics are confirmed by those of the United Kingdom.

2. The apparent increase in cancer is confined to what we have called "inaccessible" cancer. This is shown (*a*) by the Frankfort statistics; (*b*) by the fact that the difference between the rates for males and females respectively is approximately constant, and does not progressively increase with the apparent increase in cancer in each of the sexes; (*c*) because the apparent increase in cancer among the well-to-do assured lives, who are presumably attended by medical men of more than average skill, is not so great as among the general population.

3. The increase in cancer is only apparent and not real, and is due to improvement in diagnosis and more careful certification of the causes of death. This is shown by the fact that the whole of the increase has taken place in inaccessible cancer difficult of diagnosis, while accessible cancer easily diagnosed has remained practically stationary.

TABLE I.—*Age Distribution of Population, 1881.*

	MALES			FEMALES		
	England	Scotland	Ireland	England	Scotland	Ireland
25-35	329,343	331,560	267,966	323,414	308,369	276,664
35-45	256,363	251,086	238,453	249,463	244,905	243,902
45-55	186,820	186,487	193,671	186,897	189,069	188,308
55-65	130,641	128,238	155,272	133,194	136,285	157,686
65-75	70,493	71,981	95,822	75,865	82,514	88,429
75 and over	26,340	30,648	48,816	31,227	38,858	45,011
	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000

TABLE II.—Statistics of the Scottish Widows' Fund Life Office.

Age	1860-1866		1867-1873		1874-1880		1881-1887		1888-1891	
	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer
25-35	12,921	0	26,249	3	40,102	2	48,221	2	32,298	2
35-45	19,611	6	29,368	6	46,986	10	61,820	12	43,401	16
45-55	19,665	12	24,671	18	33,418	16	45,424	32	30,393	32
55-65	12,305	12	16,641	34	20,964	41	25,397	69	17,019	35
65-75	4,732	11	7,160	25	10,208	41	12,345	40	8,273	28
75 & over	1,202	1	1,798	2	2,714	6	3,770	15	2,510	16
Total ...	70,436	42	105,937	88	154,392	116	199,980	170	133,894	129

Note.—The "population at risk" in the above Table is not identical with the "number of lives at risk" as shown in the Scottish Widows' Fund reports. The figures as given by the Scottish Widows' Fund produce the function known to actuaries as "rate of mortality," viz., the probability of dying in a year. A slight adjustment has therefore been introduced, so that the resulting function may be that known to actuaries as the "central death-rate" and called the "rate of mortality" by the Registrar-General. It is the ratio between the deaths in a year and the population in the middle of that year.

TABLE III.—Population and Deaths from Cancer.—England and Wales.

Age	1860-1866		1867-1873		1874-1880		1881-1877		1888-1890	
	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer
MALES										
25-35	10,065,013	603	11,026,807	720	12,120,353	810	13,200,827	983	5,967,814	566
35-45	8,127,262	1,004	8,599,671	1,862	9,416,398	2,326	10,283,966	2,953	4,645,998	1,551
45-55	6,096,059	3,132	6,651,352	4,073	7,044,307	5,108	7,480,991	7,117	3,379,692	3,951
55-65	4,067,022	4,512	4,441,718	6,032	4,835,955	8,088	5,237,894	11,174	2,366,329	5,988
65-75	2,294,801	3,936	2,450,509	5,273	2,636,088	7,181	2,821,396	9,999	1,275,981	5,621
75 & over	852,983	1,855	917,480	2,395	983,176	3,084	1,055,189	3,921	476,838	2,095
Total . .	31,413,143	15,612	34,090,597	20,361	37,036,277	26,630	40,092,563	36,177	18,112,652	19,772
FEMALES										
25-35	11,210,266	1,772	12,156,572	2,053	13,205,566	2,304	14,331,599	2,463	6,502,206	1,209
35-45	8,709,359	5,700	9,331,399	6,784	10,154,306	8,187	11,051,894	9,309	5,011,213	4,502
45-55	6,458,701	9,552	7,147,098	11,578	7,698,205	13,991	8,282,058	16,694	3,757,516	8,277
55-65	4,382,534	9,540	4,851,651	12,109	5,377,469	15,403	5,902,299	19,044	2,677,856	9,555
65-75	2,562,017	6,881	2,835,339	8,747	3,095,121	11,304	3,361,830	14,753	1,525,252	7,945
75 & over	1,113,831	3,041	1,208,216	3,723	1,290,244	4,710	1,383,783	6,110	627,817	3,312
Total . .	34,436,708	36,486	37,530,188	41,994	40,821,211	55,899	44,313,463	68,373	20,104,890	34,800

TABLE IV.—Population and Deaths from Cancer.—Scotland.

Age	1860-1866		1867-1873		1874-1880		1881-1887		1888-1889	
	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer
MALES										
25-35	1,389,583	96	1,502,275	108	1,653,863	142	1,790,464	156	530,505	29
35-45	1,087,931	233	1,150,259	266	1,255,343	329	1,355,898	430	401,744	86
45-55	848,151	497	893,309	584	948,729	794	1,007,054	1,014	298,385	271
55-65	597,247	707	629,657	934	658,899	1,209	692,502	1,624	205,183	461
65-75	311,774	612	355,099	838	373,072	1,095	388,706	1,363	115,171	565
75 & over	136,116	326	143,341	423	154,400	550	165,505	723	49,014	450
Total . .	4,361,811	2,501	4,674,540	3,153	5,044,306	4,119	5,400,129	5,340	1,600,032	1,862
FEMALES										
25-35	1,726,740	237	1,804,835	241	1,889,282	333	1,982,381	299	585,116	25
35-45	1,314,243	807	1,393,974	820	1,485,077	1,008	1,574,353	1,199	464,699	206
45-55	1,006,538	1,328	1,070,748	1,611	1,144,345	1,869	1,215,463	2,153	358,753	552
55-65	745,462	1,445	785,837	1,669	830,411	2,071	876,125	2,491	258,595	809
65-75	427,081	1,147	480,346	1,388	507,408	1,668	530,467	2,106	156,566	870
75 & over	207,854	641	219,467	781	234,727	906	249,799	1,097	73,729	716
Total . .	5,427,918	5,605	5,755,207	6,510	6,091,250	7,855	6,428,588	9,345	1,897,458	3,178

TABLE V.—*Population and Deaths from Cancer.—Ireland.*

Age	1864-1866		1867-1873		1874-1880		1881-1887		1888-1890	
	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer	Population at Risk	Deaths from Cancer
MALES										
25-35	1,069,519	60	2,402,441	135	2,191,639	165	2,012,328	149	824,695	56
35-45	810,010	136	1,838,579	312	1,832,674	396	1,790,695	477	733,865	199
45-55	735,980	360	1,599,339	829	1,523,696	822	1,454,603	1,065	596,046	540
55-65	614,298	562	1,419,863	1,627	1,285,188	1,597	1,166,028	1,678	477,864	775
65-75	290,878	559	756,266	1,472	755,818	1,491	719,589	1,690	294,903	701
75 & over	132,009	342	327,464	853	357,385	935	366,700	1,001	150,292	480
Total . .	3,652,694	2,019	8,343,952	5,228	7,946,400	5,406	7,509,943	6,060	3,077,665	2,751
FEMALES										
25-35	1,171,915	101	2,709,747	286	2,494,890	302	2,284,409	261	930,913	112
35-45	900,181	308	2,019,910	771	2,039,629	836	2,013,894	923	820,678	416
45-55	812,882	708	1,785,658	1,496	1,664,419	1,510	1,554,855	1,744	633,616	869
55-65	667,354	731	1,533,696	1,867	1,416,704	1,981	1,302,003	2,076	530,576	952
65-75	310,299	573	773,450	1,405	767,154	1,519	730,158	1,608	297,545	720
75 & over	152,464	266	370,723	690	379,451	824	371,655	876	151,452	388
Total . .	4,024,395	2,687	9,193,184	6,515	8,762,247	6,972	8,256,974	7,488	3,364,780	3,457

TABLE VI.—*Annual Death-rate from Cancer per Million living at each Age Period.*—(See also Table II).—*Scottish Widows' Fund.*

Ages	1860-1866	1867-1873	1874-1880	1881-1887	1888-1891
25-35	Nil	114·07	49·87	41·47	61·92
35-45	305·95	204·30	212·83	185·13	368·66
45-55	610·22	729·60	478·78	704·47	1052·87
55-65	975·21	2013·15	1955·73	2716·86	2056·53
65-75	2324·60	3491·62	4016·46	3240·18	3384·50
75 & over	831·95	1112·35	2210·76	3978·78	6374·50

TABLE VII.—*Annual Death-rate from Cancer per Million living at each Age Period.*—(See also Table III).—*England and Wales.*

Ages	1860-1866	1867-1873	1874-1880	1881-1887	1888-1890
MALES					
25-35	59·91	66·11	69·31	74·11	94·84
35-45	197·36	216·52	247·02	287·15	333·84
45-55	513·78	612·08	725·13	955·36	1169·04
55-65	1109·41	1758·03	1672·47	2133·30	2530·50
65-75	1785·19	2151·80	2725·25	3540·23	4405·24
75 & over	2174·72	2610·41	3136·77	3714·87	4393·53
FEMALES					
25-35	158·07	168·88	174·47	171·86	185·94
35-45	654·47	727·02	806·26	842·30	897·85
45-55	1478·94	1619·96	1817·44	2015·68	2202·77
55-65	2176·82	2495·85	2864·36	3226·54	3568·15
65-75	2685·78	3084·99	3651·85	4388·38	5208·98
75 & over	2730·22	3164·17	3650·47	4115·13	5275·42

TABLE VIII.—*Annual Death-rate from Cancer per Million living at each Age Period. (See also Table IV).—Scotland.*

Ages	1860-1866	1867-1873	1874-1880	1881-1887	1888-1889
MALES					
25-35	69·39	71·89	85·86	87·13	54·66
35-45	214·17	231·25	262·08	317·13	214·06
45-55	585·98	653·75	836·91	1036·69	908·22
55-65	1183·77	1483·35	1834·88	2345·12	2246·77
65-75	2059·18	2355·93	2935·09	3506·51	4905·75
75 & over	2395·02	2951·01	3562·18	4368·45	9175·42
FEMALES					
25-35	137·25	133·53	176·26	150·83	42·73
35-45	614·04	588·25	678·76	761·58	443·30
45-55	1319·37	1504·56	1633·25	1771·34	1538·66
55-65	1938·40	2123·85	2493·95	2843·20	3128·44
65-75	2685·67	2889·58	3287·30	3970·09	5556·76
75 & over	3083·90	3558·65	3859·80	4391·53	9711·24

TABLE IX.—*Annual Death-rate from Cancer per Million living at each Age Period. (See also Table V).—Ireland.*

Ages	1861-1866	1867-1873	1874-1880	1881-1887	1888-1890
MALES					
25-35	56·10	56·19	75·29	74·04	67·90
35-45	167·90	169·70	216·08	266·38	271·17
45-55	489·11	518·34	539·48	732·16	905·97
55-65	914·87	1145·89	1242·62	1439·07	1621·80
65-75	1921·77	1946·41	1972·70	2348·56	2377·05
75 & over	2590·73	2604·87	2616·23	2729·75	3193·78
FEMALES					
25-35	86·18	105·55	121·07	114·25	120·31
35-45	338·65	381·70	409·88	458·32	506·90
45-55	870·98	837·79	907·22	1121·65	1371·49
55-65	1095·37	1217·32	1398·32	1594·47	1794·28
65-75	1846·61	1816·54	1980·05	2202·26	2419·80
75 & over	1714·67	1861·23	2171·56	2357·03	2561·87

TABLE X.—*Annual Deaths from Cancer in 1,000,000 living, aged 25 and over. Population distributed in Age Groups according to English Life Table No. 3, Persons (as shown in Table B).—Males.*

		Under 55	Over 55	Total
England and Wales	1860-66	165	460	625
	1867-73	189	558	747
	1874-80	220	691	911
	1881-87	277	875	1,152
	1888-90	236	1,057	1,393
Scotland	1860-66	185	510	695
	1867-73	204	615	819
	1874-80	250	757	1,007
	1881-87	304	934	1,238
	1888-89	246	1,287	1,533
Ireland	1864-66	152	462	614
	1867-73	158	503	661
	1874-80	178	521	699
	1881-87	227	597	824
	1888-90	262	650	912
Scottish Widows' Fund*	1860-66	193	431	624
	1867-73	223	733	956
	1874-80	158	824	982
	1881-87	195	948	1,143
	1888-91	312	970	1,282

TABLE XI.—*Annual Deaths from Cancer in 1,000,000 living, aged 25 and over. Population distributed in Age Groups according to English Life Table No. 3, Persons (as shown in Table B).—Females.*

		Under 55	Over 55	Total
England and Wales	1860-66	489	748	1,237
	1867-73	537	859	1,396
	1874-80	595	999	1,594
	1881-87	644	1,166	1,810
	1888-90	696	1,345	2,041
Scotland	1860-66	443	726	1,169
	1867-73	472	798	1,270
	1874-80	530	912	1,442
	1881-87	570	1,063	1,633
	1888-89	422	1,519	1,941
Ireland	1864-66	275	445	720
	1867-73	285	466	751
	1874-80	307	525	832
	1881-87	360	588	948
	1888-90	423	652	1,075

* The returns of the Scottish Widows' Fund include both males and females, and, owing to the form in which they have been prepared, it is not possible to discriminate the sexes. The proportion of females, however, is very small.

TABLE XII.—Deaths from Cancer per Million of Persons aged 25 and upwards, distributed in Age Groups according to the English Life Table No. 3.

Year	ENGLAND AND WALES		SCOTLAND		IRELAND		SCOTTISH WIDOWS' FUND EXPERIENCE
	Males	Females	Males	Females	Males	Females	Persons
1860	587	1,185	668	1,155	591	717	695
61	597	1,200	672	1,157	599	718	708
62	608	1,215	678	1,160	607	719	723
63	619	1,235	690	1,163	614	720	740
64	637	1,254	704	1,169	622	721	756
65	655	1,273	718	1,181	629	722	763
66	672	1,297	735	1,198	636	723	783
67	685	1,320	754	1,212	643	727	800
68	705	1,342	772	1,226	649	733	816
69	725	1,366	792	1,247	655	740	830
1870	747	1,394	815	1,269	661	750	847
71	767	1,421	840	1,288	667	759	862
72	790	1,450	865	1,311	673	769	880
73	810	1,479	895	1,337	679	780	900
74	832	1,507	924	1,365	684	793	918
75	857	1,537	957	1,393	691	802	938
76	880	1,565	980	1,418	697	817	958
77	908	1,594	1,007	1,440	699	832	972
78	940	1,623	1,036	1,466	701	842	992
79	965	1,652	1,059	1,492	703	860	1,015
1880	995	1,680	1,086	1,520	718	878	1,038
81	1,020	1,705	1,117	1,542	737	891	1,061
82	1,058	1,737	1,147	1,562	762	907	1,085
83	1,101	1,775	1,186	1,589	800	935	1,115
84	1,143	1,805	1,224	1,618	837	943	1,143
85	1,197	1,840	1,270	1,657	860	965	1,172
86	1,245	1,880	1,329	1,698	880	989	1,200
87	1,300	1,928	1,393	1,765	892	1,015	1,225
88	1,341	1,985	1,476	1,870	902	1,040	1,250
89	1,393	2,038	1,590	2,012	912	1,073	1,270
1890	1,445	2,100	1,740	2,197	922	1,112	1,290

TABLE XIII.—Deaths from Cancer in Frankfort-on-Main at all Ages.

Part of Body affected	1860-1866.		1867-1873		1874-1880		1881-1887		1888-1889	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
Position Undefined	33	29	18	30	42	20	58	55	19	17
Nervous System	5	3	8	5	4	1	10	10	...	...
Heart . . . . .	...	1	...	...	...	...	...	...	...	...
Respiratory Organs	2	3	2	1	8	4	8	3	1	2
Tongue	4	...	4	...	1	4	7	1	4	1
Esophagus and Pharynx	6	2	5	3	15	4	30	11	11	1
Stomach	36	55	46	58	80	73	104	121	34	29
Intestines	19	17	18	29	38	37	22	57	22	21
Intra and Retro-Peritoneal	5	5	6	16	9	18	9	20	1	6
Liver	23	27	36	40	51	57	67	72	14	36
Pancreas and Spleen . . . . .	...	1	1	1	4	1	1	4	...	1
Kidneys	1	1	4	2	4	2	7	3	3	...
Prostate, Urinary Bladder, and Penis	7	1	10	4	7	1	14	5	3	4
Uterus . . . . .	...	69	...	96	...	117	...	159	...	64
Ovaries . . . . .	...	9	...	9	...	17	...	20	...	12
Mamma . . . . .	...	43	...	42	...	60	...	41	...	21
Vagina . . . . .	...	1	...	2	...	5	...	5	...	3
Bone	2	...	2	...	5	1	5	1	...	...
Total	143	267	160	338	268	422	342	588	112	218

TABLE XIV.—Deaths from Cancer in Frankfort-on-Main over 20 Years of Age.

Age	1860-1866		1867-1873		1874-1880		1881-1887		1888-1889	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
20-30	3	5	5	3	7	5	6	15	1	3
30-40	10	13	17	32	19	40	34	50	4	20
40-50	18	51	20	65	47	92	57	123	26	41
50-60	50	86	40	95	60	112	94	143	39	61
60-70	36	70	47	80	79	99	88	151	24	61
70-80	19	35	26	54	43	67	46	75	16	24
80 and over	4	4	3	5	5	5	5	20	2	6
Total .	140	264	158	334	260	420	330	577	112	216

Age	1860-1866		1867-1873		1874-1880		1881-1887		1888-1889	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
α.—Accessible Cancer										
20-30	0	1	0	0	0	0	0	4	0	0
30-40	0	6	1	19	0	21	1	26	0	12
40-50	0	36	2	28	0	53	4	63	2	23
50-60	6	40	0	51	0	51	1	62	0	27
60-70	3	25	6	30	0	46	0	34	2	21
70-80	0	7	0	14	1	14	1	13	0	5
80 and over	1	0	0	1	0	1	0	4	0	1
Total	10	115	9	143	1	186	7	206	4	89
β.—Inaccessible Cancer										
20-30	1	4	3	3	6	5	1	10	0	3
30-40	4	6	13	11	17	15	21	21	4	5
40-50	14	9	15	33	40	36	41	46	18	14
50-60	34	36	35	34	50	54	80	61	32	32
60-70	27	39	38	44	71	50	78	104	20	37
70-80	16	23	25	36	32	50	42	59	13	15
80 and over	1	4	3	3	4	4	3	14	2	5
Total	97	121	132	164	220	214	269	318	89	111
γ.—Cancer, Position Undefined										
20-30	2	0	2	0	1	0	5	1	1	0
30-40	6	1	3	2	2	4	12	3	0	3
40-50	4	6	3	4	7	3	9	14	6	4
50-60	10	10	5	10	10	7	13	17	7	2
60-70	6	6	3	6	8	3	10	13	2	3
70-80	3	5	1	4	10	3	3	3	3	4
80 and over	2	0	0	1	1	0	2	2	0	0
Total	33	28	17	27	39	20	54	53	19	16

TABLE XV.—*Population at Risk in Frankfort-on-Main.*

Age	1860-1866	1867-1873	1874-1880	1881-1887	1888-1889
MALES					
20-30	90,404	76,174	90,222	96,183	28,630
30-40	42,294	49,166	69,410	87,654	27,072
40-50	29,201	30,964	40,993	57,471	19,306
50-60	18,924	20,036	23,860	30,224	10,102
60-70	10,850	11,556	12,918	16,158	5,224
70-80	3,700	4,228	5,116	6,292	1,973
80 and over	617	750	919	1,137	366
Total	195,990	192,874	243,438	295,119	92,673
FEMALES					
20-30	74,536	85,365	108,009	133,871	41,545
30-40	40,880	50,361	70,137	91,459	28,576
40-50	27,260	31,019	41,705	60,116	20,364
50-60	19,645	21,320	26,813	34,575	11,467
60-70	12,172	13,881	16,524	21,439	6,926
70-80	4,272	5,288	7,008	8,957	2,786
80 and over	1,110	944	1,077	1,904	732
Total	179,875	208,178	271,273	352,321	112,396

TABLE XVI.—*Frankfort.—Annual Deaths from Cancer in 1,000,000 living, aged 25 Years and over.—Population distributed in Age Groups according to English Life Table No. 3, Persons (as shown in Table C).*

	Accessible	Inaccessible	Position undefined	Total
MALES				
1860-66	126	1,118	359	1,603
1867-73	88	1,421	137	1,646
1874-80	14	1,913	363	2,290
1881-87	35	1,865	305	2,205
1888-89	74	1,888	356	2,318
FEMALES				
1860-66	1,081	1,323	293	2,697
1867-73	1,214	1,540	254	3,008
1874-80	1,220	1,588	131	2,939
1881-87	981	1,820	272	3,073
1888-89	1,329	1,930	256	3,515

On the Rates of Mortality in New South Wales and Victoria, and the Construction of a Mortality Table from a single Census and the Deaths in the Years adjacent thereto. By ELPHINSTONE McMAHON MOORS, M.A., *of Sydney University and Fellow of the Institute of Actuaries, and* WILLIAM REGINALD DAY, *of the Standard Life Association, Limited, Sydney, Fellow of the Institute of Actuaries.*

[Read before the Institute, 25 March 1901.]

(1). IN the following pages we give a description of the method pursued in an investigation into the Mortality Rates of the combined populations of New South Wales and Victoria, also tabular statements of the results at which we arrived. We offer no apology for trespassing on the courtesy of the Institute and asking their attention to a paper on such a well-worn subject as mortality rates, inasmuch as the rates of mortality being experienced by persons living in different parts of the world, are in themselves of more than passing interest. Moreover, where the population under consideration has been largely transplanted from a home on one side of the globe to a new land on the other, amidst new surroundings, experiencing a new climate, and cultivating almost virgin soil, its progress in the social scale will probably attract more than usual attention. The Australian Colonies afford an excellent example of such a new nation, and their rapid development makes their experience in mortality a subject of more than usual moment, both to themselves and to the mother country. Not only is there the desire to compare their present mortality rates with those prevailing in the mother land but there is the additional incentive to enquiry as to whether their own present experience is varying from that of their earlier days. To those engaged in the conduct of Industrial Business, rates of mortality, derived from the statistics of the general population, are an absolute necessity; and as industrial assurance is now making rapid strides in the Australian Colonies, a paper dealing with Australian mortality should be welcomed by those most closely associated with that class of business.

I.—PREVIOUS AUSTRALIAN INVESTIGATIONS.

(2). The fact that Australian statistics have been available in such a complete form, has been an inducement to actuaries to make use of them, and Australia has been fortunate in having had investigations made into her mortality rates from time to time. Although perhaps no definite conclusions have been arrived at, partly owing to the paucity of the numbers in the population at the advanced ages, nevertheless, certain distinctive features are discernible in the tables. The mortality at the early and middle ages has been found to be very favourable, in spite of a somewhat severe accident risk in early manhood. This risk of accident is doubtless due to the rough pioneering life led by settlers in the bush; but as the country becomes more opened up, and communication with the interior is facilitated, the feature may be expected to become less prominent. We may here mention that we have not considered it within the scope of the paper to investigate the causes of death or the reasons why our rates differ to a sensible extent from those in the old country some forty years ago and from those of earlier date in this southern land.

(3). The earliest Australian investigation of importance was that made by Professor Pell, of Sydney University, which was the subject of a paper read before the Institute in 1879, and published in *J.I.A.*, vol. xxi, p. 257. His figures related to New South Wales only, and are founded on the deaths from 1860 to 1875 and the census returns of 1861 and 1871. Apart from its historical value, the paper is of interest for the method used in ascertaining the rate of mortality at the infantile ages—a method which has received the seal of approval through its adoption in subsequent investigations of a similar character. For the advanced ages, Professor Pell closed his own figures at age 75 and used the English Life No. 3 rates, slightly increased, to complete his table.

(4). More widely known are the two investigations made by Mr. Burridge's Mr. A. F. Burridge, F.I.A., and his demonstration in Victorian Tables, them of the soundness of Milne's method of constructing the Carlisle Table. Mr. Burridge's first investigation dealt exclusively with the figures of the Colony of Victoria, but as the rates were deduced from the deaths in a single year and the population in a single census (1871), the results can hardly

be regarded as conclusive, owing to the paucity of the data. His estimated mean population numbered 402,975 males and 334,047 females or a total of 737,022 persons. The deaths numbered 5,845 males and 4,072 females, or a total of 9,917 persons. For the infantile ages he used a method very similar to that of Professor Pell, and completed his tables at the advanced ages by using English Life No. 1 rates—"males (above 80) taken one year older; and for females from age 70 . . . taken one year younger" (*J.I.A.*, vol. xxiii, p. 321).

(5). The second investigation made by Mr. BurrIDGE, published Mr. BurrIDGE's Australian Tables. in *J.I.A.*, vol. xxiv, was of far greater value. The data was drawn from three Colonies, New South Wales, Victoria and Queensland, and the mean populations between the census dates of 1871 and 1881 were taken. The numbers used were 876,619 males and 728,516 females, or a total of 1,605,135 persons. The deaths were taken from the returns for the years 1870 to 1881 inclusive, and numbered for the twelve years 172,210 males and 120,290 females, or a total of 292,500 persons. As showing the possible effects of migration, Mr. BurrIDGE pointed out that the population had been increased by over 300,000 immigrants between 1873 and 1881. For the advanced ages, 80 and over, he, "finding that the English rate above 80 exceeded the Colonial rate by a small percentage . . . deduced the rates for particular ages by deducting the same percentage from each corresponding Healthy English rate." He sums up his results as establishing "the fact that a low mortality has prevailed in Australia; and further, that the special characteristics of the population are of sufficient interest and importance to render it desirable that they should appear in a separate mortality table."

It may be briefly stated here that the low rate of mortality, found by Mr. BurrIDGE to exist, is still as noticeable as ever.

II.—THE REQUIREMENTS FOR A MORTALITY EXPERIENCE.

(6). It may not be out of place to briefly set out what are the essential requirements for a mortality experience, Adequate Data. so that it may be seen to what extent our results may be relied upon. Firstly, it is absolutely necessary that the data should be ample and accurate. For a "general population" table it is usually a matter of little difficulty to satisfy the former

requirement. What should constitute a minimum so far as numbers are concerned we do not feel called upon to state; though Mr. Burrige appears to regard the numbers available in his second investigations as sufficient. Accuracy in the data is a more difficult matter. The ages given in the census papers and death registers can only be regarded as approximations, though probably those in the death registers are more nearly accurate than those in the census papers. That such inaccuracies exist is patent to anyone who takes the trouble to compare the age groups about age 50 in either the census or death returns. They appear in both male and female returns, though the irregularities are somewhat more striking among the latter. Australian returns also show that people are as partial there, as in other parts of the world, to giving their ages to the nearest age with 0 or 5.

(7). The question of the statisticians using quinquennial groups has already been adversely commented on in the pages of the *Journal*, and we would like to see the objections to the method urged and urged again, until the authorities entirely abandoned the habit of grouping together the figures of different ages; or, if that be asking too much, that the grouping in quinquennial ages should be such that the popular or fancied ages, 45, 50, 55, &c., should be the central ages instead of as at present one of the terminal ages of the groups.

(8). Of equal importance with the adequacy of the data is the use of a proper method in constructing the table. In the case of general population tables the choice of method is limited, that is, if we exclude the question of final graduation from this heading. The method adopted by Milne in constructing the Carlisle Table has received the sanction of modern public approval and it seems likely to maintain its popularity. Even should statistics eventually become available in annual groups the errors in age must cause grave irregularities in rates derived directly from them, and throw upon a final graduation, a far heavier task than, in the opinion of the writers, any process of graduation can be fairly called upon to support.

It is possible perhaps that Milne's method may be modified, should annual groupings be adopted by the statisticians, in the way of putting these as ordinates on cross-ruled paper and tracing a preliminary curve through them, after the manner of Dr. Sprague's Graphic Graduation.

III.—THE PRESENT AUSTRALIAN EXPERIENCE.

(9). It might have been thought that, with the principles for the formation of a table so clearly laid down by Mr. Burridge, his method would have been exactly followed, merely substituting the two censuses of 1881 and 1891 and the concomitant deaths for the censuses of 1871 and 1881. There is, however, considerable hazard in the use of this method, where, as in Australia, the migration element is largely present, and its force is not evenly distributed over the whole period under review. Thus it would be quite possible for a light death rate occurring during a limited period, where immigration was very heavy, to materially misrepresent the actual mortality for the whole decade. Another fact which had some weight in our determination to adopt a single census method, was that, by the double census method, the mortality shown really dates back to five years before the second census. In a country undergoing rapid change, such as Australia, this is a matter of some importance.

(10). We desired to exclude from our tables any possible effect from special mortality arising from residence within the tropics, and for this reason Queensland and South Australian figures were omitted. Probably though, the rates deduced from New South Wales and Victoria, whose experience we finally selected, will be found to closely correspond with those in the non-tropical portions of the other two Colonies and those in Tasmania.

(11). The last census of the two selected Colonies was taken on the night of the 5 April 1891, which for convenience of calculation was taken as 31 March 1891. No appreciable error is likely to be thereby introduced, as even supposing a population to be increasing at the rate of 20 per-cent per annum, the correction needed would amount to no more than 2·5 per thousand. The summary of the censuses is shown in the following table.

Non-tropical
Experience.

TABLE A.—*Population of the Colonies of New South Wales and Victoria, as shown in the Censuses of 1891.*

Colony	Males	Females	Persons
New South Wales . . .	612,562	519,672	1,132,234
Victoria	598,414	541,991	1,140,405
Total	1,210,976	1,061,663	2,272,639

(12). These figures include the Chinese and Aboriginal population, as it was found, in tabulating the deaths that they could not be eliminated from the latter on account of numbers of them being registered under European names. Anyhow, their inclusion is unlikely to make any appreciable difference, their numbers being very small in proportion to the total population, as will be seen from the following table.

TABLE B.—*Chinese and Aborigines (including Half-Castes) included in the Census Figures.*

Colony	Males	Per-cent	Females	Per-cent	Persons	Per-cent
New South Wales . . .	18,114	3.0	4,322	.8	22,436	2.0
Victoria	9,097	1.5	845	.2	9,942	.9
Total	27,211	2.2	5,167	.5	32,378	1.4

As the Aborigines are dying out somewhat rapidly in both Colonies, the mortality rates we have deduced are probably slightly in excess of the true rates being experienced among the white population.

(13). The deaths were extracted from the returns of the Deaths. Registrars-General of the two Colonies, and were taken for two years on each side of the census date. They thus cover a period from 1 April 1889 to 31 March 1893, or four years in all. In order to ascertain the deaths for a year ending on 31 March, an even distribution throughout each year was assumed, and one-fourth of the deaths registered in each calendar year was added to three-fourths of those registered in the preceding calendar

year. Thus the deaths for the year ending 31 March 1891 were taken as one-fourth of those registered in 1891, added to three-fourths of those registered in 1890. It was necessary to re-group the deaths in the above manner, in order to allow for a correction for migration, as explained subsequently. The total deaths for the period are given in the following table.

TABLE C.—*Total Deaths in New South Wales and Victoria for the Period of Four Years ending 31 March 1893.*

Colony	Males	Females	Persons
New South Wales .	35,214	24,805	60,019
Victoria	40,819	30,346	71,165
Total	76,033	55,151	131,184

(14). It is necessary in employing such a method of construction as that indicated above, to clearly prove that the years over which the observations extend, have not been marked by extremes in the way of mortality. The rates per thousand of population in the two Colonies are given in the following table.

Average
Mortality-
Years.

TABLE D.—*Death Rates per Thousand of Population for each of the Years 1886 to 1895 inclusive.*

Year	MALES		FEMALES		Year
	New South Wales	Victoria	New South Wales	Victoria	
1886	15.95	16.49	13.95	13.72	1886
1887	14.12	17.13	12.49	14.19	1887
1888	14.94	16.80	12.67	13.90	1888
1889	14.93	19.19	12.61	16.21	1889
1890	13.82	17.60	11.81	14.44	1890
1891	15.41	17.75	12.86	14.59	1891
1892	13.38	14.99	10.81	12.15	1892
1893	14.23	15.72	12.07	12.36	1893
1894	13.08	14.68	11.30	11.49	1894
1895	12.77	11.66	10.66	11.76	1895
Average for 10 Years	14.20	16.53	12.05	13.45	{ Average for 10 years.

Of course, the above table proves nothing conclusively, but it shows that no unduly light years of mortality have been selected if we except that of the females of New South Wales in 1892. The female mortality in general, appears so light that we feel somewhat dubious in asking for reliance to be placed on our female rates until satisfactory evidence can be obtained in corroboration of them.

IV.—CONSTRUCTION OF THE TABLES.

(15). Our choice of a method for the construction of the tables was, as indicated above, practically limited to Milne's Carlisle Method. that used by Milne for the Carlisle Table, except for the youngest ages at which p_x , the fundamental value, could be more accurately ascertained by using Professor Pell's method. At the outset, however, a difficulty arose in the application of the Carlisle method. This lay in obtaining a properly ruled surface of sufficient size to enable exact readings of the ordinates to be made. Finally, a pine table, 5 ft. by 3 ft., was obtained and cross-ruled into half-inch squares, and this was found to work admirably, the curves being traced out by means of a length of cotton pinned into the required position. The table was in fact a compromise between Milne's Board-room floor and Layton's cross-ruled paper, the latter being deemed too small for the reading of the ordinates.

(16). The numbers living in the quinquennial groups were taken direct from the census returns. These returns, Populations and Deaths in Age Groups. it may be mentioned, state that "the numbers at unspecified ages have been distributed amongst the various groups by a process of graduation." What the exact process was, we did not ascertain, but as the total number affected was comparatively trifling, we had no hesitation in accepting the figures as given, and they will be found in the following table.

TABLE E.—*Populations of New South Wales and Victoria in Age Groups.*

Age Groups	MALES		Total	FEMALES		Total	Age Groups
	New South Wales	Victoria		New South Wales	Victoria		
0 to 4	84,030	75,229	159,259	81,751	73,508	155,259	0 to 4
5 " 9	72,909	65,460	138,369	71,374	63,557	134,931	5 " 9
10 " 14	62,238	58,922	121,160	61,196	57,782	118,978	10 " 14
15 " 19	54,272	57,116	111,388	54,486	57,718	112,204	15 " 19
20 " 24	58,156	63,625	121,781	53,509	62,402	115,911	20 " 24
25 " 29	60,140	63,204	123,344	47,026	55,232	102,258	25 " 29
30 " 34	52,327	47,876	100,203	36,749	39,856	76,605	30 " 34
35 " 39	40,542	31,843	72,385	27,347	26,529	53,876	35 " 39
40 " 44	31,573	24,058	55,631	22,272	21,443	43,715	40 " 44
45 " 49	27,161	22,135	49,299	18,687	19,672	38,359	45 " 49
50 " 54	22,845	22,821	45,666	14,879	19,395	34,274	50 " 54
55 " 59	16,781	22,277	39,061	10,833	16,223	27,056	55 " 59
60 " 64	12,741	20,223	32,964	7,779	12,921	20,700	60 " 64
65 " 69	7,060	11,145	18,205	4,915	7,182	12,097	65 " 69
70 " 74	5,048	7,242	12,290	3,692	4,803	8,495	70 " 74
75 " 79	2,842	3,213	6,055	1,903	2,267	4,170	75 " 79
80 " 84	1,294	1,389	2,683	877	1,012	1,889	80 " 84
85 " 89	422	463	885	284	359	643	85 " 89
90 " 94	142	145	287	79	112	191	90 " 94
95 " 99	21	23	44	27	13	40	95 " 99
100 & over	12	5	17	7	5	12	100 & over
Total	612,562	598,414	1,210,976	519,672	541,991	1,061,663	Total

The following tables give similar information as to the deaths:

TABLE F.—Male Deaths in New South Wales and Victoria in Age Groups.

Ages	NEW SOUTH WALES					VICTORIA					Ages
	1890	1891	1892	1893	Total	1890	1891	1892	1893	Total	
0	2,485	2,317	2,513	2,430	9,745	2,834	2,423	2,480	2,232	9,969	0
1	500	445	493	501	1,939	631	515	483	481	2,110	1
2	194	220	206	203	823	230	191	145	159	725	2
3	115	133	138	137	523	156	146	116	103	521	3
4	93	99	111	91	397	129	121	95	73	418	4
0 to 4	3,387	3,214	3,461	3,365	13,427	3,980	3,396	3,319	3,048	13,743	0 to 4
5	236	281	253	251	1,021	341	328	247	232	1,148	5
10	161	135	133	149	578	175	178	141	131	625	10
15	180	171	202	180	733	261	222	198	203	887	15
20	261	272	295	271	1,102	421	399	353	276	1,449	20
25	391	365	377	342	1,475	483	465	399	384	1,731	25
30	352	359	398	353	1,462	402	421	358	347	1,528	30
35	343	357	389	379	1,468	329	342	325	301	1,298	35
40	324	336	376	329	1,365	338	319	315	263	1,235	40
45	372	383	399	364	1,518	391	389	388	322	1,490	45
50	404	426	459	424	1,713	517	479	477	388	1,861	50
55	382	401	440	384	1,607	651	636	673	565	2,525	55
60	415	465	512	452	1,844	787	854	866	729	3,236	60
65	344	362	396	363	1,465	593	627	669	610	2,499	65
70	349	375	408	385	1,517	513	584	616	598	2,341	70
75	295	309	352	339	1,295	353	402	424	397	1,576	75
80	199	189	222	207	817						80 & over
85	101	104	130	101	436	343	392	470	405	1,610	
90	30	47	47	38	162						
95	14	11	11	7	43						
100 & over	5	2	5	3	15						
Unspecified	33	37	39	42	151	13	9	6	9	37	Unspecified
Total	8,581	8,601	9,304	8,728	35,214	10,894	10,442	10,275	9,208	40,819	Total

Ages	NEW SOUTH WALES					VICTORIA					Ages
	1890	1891	1892	1893	Total	1890	1891	1892	1893	Total	
0	2,037	1,910	2,066	1,914	7,927	2,430	2,102	2,175	1,875	8,582	0
1	538	448	457	454	1,897	596	510	445	423	1,974	1
2	184	190	166	184	729	194	173	147	194	669	2
3	109	126	116	121	472	133	141	97	84	455	3
4	82	72	73	93	320	118	108	75	66	367	4
0 to 4	2,950	2,746	2,878	2,771	11,345	3,471	3,034	2,939	2,603	12,047	0 to 4
5	211	250	240	226	927	299	290	212	189	990	5
10	110	107	103	122	442	190	173	127	123	613	10
15	171	154	168	182	675	263	242	195	201	901	15
20	238	225	216	231	910	374	351	325	294	1,314	20
25	268	271	261	241	1,041	399	385	380	318	1,482	25
30	234	253	243	258	988	316	326	335	325	1,302	30
35	207	215	259	229	910	258	275	278	239	1,050	35
40	191	214	215	199	819	259	299	278	219	1,025	40
45	199	185	226	191	801	275	258	274	222	1,029	45
50	174	194	199	207	774	315	274	281	276	1,146	50
55	186	200	237	190	813	338	331	344	317	1,330	55
60	159	198	235	214	806	323	354	392	346	1,415	60
65	182	206	218	184	790	292	320	343	302	1,257	65
70	192	246	296	228	962	292	320	371	315	1,298	70
75	184	220	236	171	811	214	219	258	223	914	75
80	120	131	159	129	539						80
85	65	76	72	59	272						85
90	21	26	28	23	98	279	301	327	287	1,194	90
95	10	10	9	9	38						95
100 & over	2	1	4	5	12	3	1	2	3	9	100 & over
Unspecified	5	7	9	11	32						Unspecified
Total	6,079	6,135	6,511	6,080	24,805	8,160	7,723	7,661	6,802	30,346	Total

(17). Before proceeding with the construction of the table, some adjustment had to be made for the effect of migration upon total population. Had the migration proceeded at a uniform rate throughout the four years, no correction would have been needed; but, unfortunately, an examination of the migration statistics showed that the rate sensibly slackened during the latter portion of the period. The migration figures altered, like the deaths, to years ending on 31 March were as follows:

TABLE H.—*Migrants (Male and Female) for Four Years—the Negative Sign denoting a Loss by Migration.*

Period ending 31 March	MALES		FEMALES		Period ending 31 March
	New South Wales	Victoria	New South Wales	Victoria	
1890	6,128	9,471	3,877	6,642	1890
1891	9,374	8,449	7,166	5,837	1891
1892	8,715	3,161	8,166	2,230	1892
1893	2,990	-3,801	2,399	-2,499	1893

In the application of the correction for the migrants the ages of the migrants were assumed to lie between 15 and 64, and to be distributed in proportion to the population at each age. The correction formulæ are given below and their symbols are to be interpreted as

${}^n d_x$. . . the original deaths in age group x to $x+4$ in the year of experience $1890+n$.

${}^n d'_x$. . . the adjusted deaths in age group x to $x+4$ in the year of experience $1890+n$.

${}^n M$. . . the migrants for the year of experience $1890+n$ taken from Table H.

L . . . the total population in the age groups 15–19 up to 60–64 inclusive.

Then

$${}^0 d'_x = \frac{L \times {}^0 d_x}{L - {}^1 M - \frac{1}{2} {}^0 M}$$

$${}^1 d'_x = \frac{L \times {}^1 d_x}{L - \frac{1}{2} {}^1 M}$$

$${}^2 d'_x = \frac{L \times {}^2 d_x}{L + \frac{1}{2} {}^2 M}$$

$${}^3 d'_x = \frac{L \times {}^3 d_x}{L + {}^2 M + \frac{1}{2} {}^3 M}$$

(18). The formulæ were applied to each of the death groups for the ages mentioned, with the exception of those of the female deaths in New South Wales. The variation made in the other figures, where the rate of migration was irregular, was so small as to prove any adjustment unnecessary where, as in this case, the rate was fairly continuous. The deaths at unspecified ages were distributed *pro rata* excluding the two age groups under 10. The final figures for the deaths are given in the following table, and one-fourth of the numbers in the final column were those used in the construction of the table.

[TABLE J, p. 164.]

(19). The figures were then set out in parallelogram form upon the table, the parallelograms being set back each for half an age in order to facilitate the reading of the central ordinates. In one or two cases, decennial in place of quinquennial groups were taken, the curves being found to run more smoothly by this means. No objection can be taken to this as it merely utilizes to the full one of the main advantages of the method, namely, its elasticity. Diagrams Nos. I to IV in the Appendix are reproductions of the parallelograms and curves, the quinquennial parallelograms being put in with dotted lines where a decennial grouping was adopted. The greatest care was taken in tracing the curves, so as to carry out Milne's instruction to make each portion added to a parallelogram equal to that cut off from it. This was greatly facilitated by the size of our table. The values of the ordinates, when read off, were summed for each five or ten values and their total compared with the numbers in the original facts. The values of the ordinates are given in the following table.

[TABLE K, pp. 165, 166.]

(20). The fact that the deaths in the Victorian returns were grouped for ages 80 and over, necessitated drastic treatment for the final ages of the table. Several experiments were made, amongst others, that of subdividing the Victorian deaths from 80 to the end of life in the same proportions as those recorded in New South Wales; but all resulted unsatisfactorily. The method finally adopted was as follows. Values of the p_x were deduced from the facts from 65 to 79, and were set out as ordinates on the table. Similar values of p_x for ages 80 and over, were deduced from the New South Wales figures only and set out: a curve was then drawn taking in the

TABLE J.—*Adjusted Deaths, as used in the Calculations.*

Ages	ORIGINAL DEATHS			ADJUSTED DEATHS		
	New South Wales	Victoria	Total	New South Wales	Victoria	Total
MALES						
0-4	13,427	13,743	27,170	13,427	13,743	27,170
5-9	1,021	1,148	2,169	1,021	1,148	2,169
10-14	578	625	1,203	582	626	1,208
15-19	733	887	1,620	737	901	1,638
20-24	1,102	1,449	2,551	1,110	1,472	2,582
25-29	1,475	1,731	3,206	1,488	1,757	3,245
30-34	1,462	1,528	2,990	1,474	1,550	3,024
35-39	1,468	1,298	2,766	1,478	1,316	2,794
40-44	1,365	1,235	2,600	1,375	1,254	2,629
45-49	1,518	1,490	3,008	1,530	1,512	3,042
50-54	1,713	1,861	3,574	1,725	1,890	3,615
55-59	1,607	2,525	4,132	1,618	2,561	4,179
60-64	1,844	3,236	5,080	1,856	3,281	5,137
65-69	1,465	2,499	3,964	1,476	2,503	3,979
70-74	1,517	2,341	3,858	1,528	2,344	3,872
75-79	1,295	1,576	2,871	1,304	1,578	2,882
80 & over	1,473	1,610	3,083	1,483	1,612	3,095
Unspecified	151	37	188	...	...	...
Total	35,214	40,819	76,033	35,212	41,048	76,260
FEMALES						
0-4	11,345	12,047	23,392	11,345	12,047	23,392
5-9	927	990	1,917	927	990	1,917
10-14	442	613	1,055	442	613	1,055
15-19	675	901	1,576	675	910	1,585
20-24	910	1,344	2,254	913	1,358	2,271
25-29	1,041	1,482	2,523	1,044	1,497	2,541
30-34	988	1,302	2,290	991	1,314	2,305
35-39	910	1,050	1,960	913	1,061	1,974
40-44	819	1,025	1,844	821	1,036	1,857
45-49	801	1,029	1,830	803	1,039	1,842
50-54	774	1,146	1,920	776	1,157	1,933
55-59	813	1,330	2,143	815	1,342	2,157
60-64	806	1,415	2,221	808	1,428	2,236
65-69	790	1,257	2,047	792	1,258	2,050
70-74	962	1,298	2,260	965	1,299	2,264
75-79	811	914	1,725	813	914	1,727
80 & over	959	1,194	2,153	962	1,194	2,156
Unspecified	32	9	41	...	...	...
Total	24,805	30,346	55,151	24,805	30,457	55,262

TABLE K.—*Populations and Deaths distributed for each Age.*

Age	MALES		FEMALES		Age
	Population	Deaths	Population	Deaths	
5	29,100	156·0	28,540	132·0	5
6	28,400	125·0	27,700	109·5	6
7	27,695	102·3	26,950	92·0	7
8	26,950	85·0	26,220	79·0	8
9	26,225	74·0	25,520	66·8	9
10	25,460	66·7	24,875	55·5	10
11	24,790	58·6	24,300	51·3	11
12	24,200	56·2	23,750	50·0	12
13	23,630	58·3	23,230	51·3	13
14	23,080	62·2	22,825	55·6	14
15	22,630	67·1	22,490	63·0	15
16	22,150	73·0	22,325	71·0	16
17	21,900	80·8	22,240	79·2	17
18	22,050	89·7	22,450	87·4	18
19	22,660	98·9	22,700	95·6	19
20	23,410	108·7	23,050	103·2	20
21	24,010	118·7	23,295	108·8	21
22	24,460	128·7	23,370	114·0	22
23	24,820	139·1	23,295	118·8	23
24	25,080	150·3	22,900	123·0	24
25	25,180	159·2	22,340	125·7	25
26	25,125	163·7	21,470	127·9	26
27	24,900	164·8	20,450	128·7	27
28	24,490	163·7	19,520	127·4	28
29	23,650	159·8	18,480	125·6	29
30	22,405	156·2	17,375	122·3	30
31	21,150	153·0	16,300	118·9	31
32	20,000	151·0	15,255	115·3	32
33	18,850	148·6	14,300	111·7	33
34	17,800	147·2	13,375	108·1	34
35	16,550	145·4	12,260	101·2	35
36	15,400	143·0	11,320	100·6	36
37	14,430	110·0	10,615	98·1	37
38	13,375	136·6	10,070	95·9	38
39	12,630	133·5	9,610	94·7	39
40	11,800	131·9	9,310	93·8	40
41	11,380	130·6	9,005	93·2	41
42	11,100	130·3	8,710	92·8	42
43	10,800	131·1	8,455	92·4	43
44	10,550	133·4	8,235	92·1	44
45	10,320	139·0	8,020	91·7	45
46	10,120	145·0	7,850	91·3	46
47	9,970	152·2	7,660	91·6	47
48	9,795	159·1	7,545	92·5	48
49	9,625	165·2	7,405	93·4	49
50	9,445	170·7	7,320	93·8	50
51	9,245	176·0	7,070	94·8	51
52	9,045	180·5	6,865	96·4	52
53	8,825	185·3	6,620	98·0	53
54	8,575	191·2	6,280	100·3	54

TABLE K—(continued).

Age	MALES		FEMALES		Age
	Population	Deaths	Population	Deaths	
55	8,330	196·5	6,000	103·5	55
56	8,080	202·6	5,680	106·8	56
57	7,810	209·1	5,360	108·6	57
58	7,550	215·5	5,120	109·8	58
59	7,290	221·1	4,895	110·6	59
60	6,980	226·4	4,645	111·2	60
61	6,590	230·4	4,395	111·7	61
62	6,180	233·2	4,160	112·0	62
63	5,800	234·6	3,885	112·1	63
64	5,360	233·4	3,615	112·0	64
65	4,870	231·5	3,280	111·9	65
66	4,435	228·5	2,940	111·5	66
67	4,010	224·7	2,610	111·0	67
68	3,640	220·8	2,300	110·2	68
69	3,305	215·5	2,030	109·3	69
70	2,965	210·5	1,810	108·2	70
71	2,715	202·5	1,630	107·0	71
72	2,465	193·9	1,470	105·6	72
73	2,210	185·2	1,330	103·4	73
74	1,935	175·9	1,190	100·4	74
75	1,640	166·0	1,065	95·8	75
76	1,390	155·5	950	91·3	76
77	1,195	143·5	830	86·7	77
78	1,000	132·5	720	81·6	78
79	830	123·0	605	76·4	79
80	715	107·0	509	70·3	80
81	610	96·4	435	65·0	81
82	530	89·5	375	60·6	82
83	450	80·7	315	54·8	83
84	380	73·0	255	47·8	84
85	290	59·6	199	40·5	85
86	215	47·5	154	33·5	86
87	165	39·0	120	28·1	87
88	120	30·2	100	25·3	88
89	95	25·7	70	18·9	89
90	80	23·9	55	16·0	90
91	69	21·4	45	14·0	91
92	58	19·3	36	12·1	92
93	46	16·4	30	11·0	93
94	34	13·2	25	9·8	94
95	22	9·3	17	7·2	95
96	14	6·4	12	5·6	96
97	8	4·0	6	3·0	97
98	6	3·3	3	1·6	98
99	5	3·2	3	1·8	99
100	3	2·1	3	2·1	100
101	2	1·6	3	2·7	101
102	1	1·1	2	2·2	102
103	...	...	2	3·0	103
104	...	...	1	2·0	104

values from ages 65 to 79 (and consequently not quite smooth), passing amongst the points between 80 and the end and finally vanishing at the age 103 in each table. From these graphic values of p_x , m_x was obtained and applied to the figures of the population curve, and the sum of the resulting d_x values was taken and compared with the actual number of deaths registered. After one or two trials, completely satisfactory results were obtained. The values of d_x thus obtained are printed in old-faced type in Table K, and are drawn with dotted lines in Diagrams III and IV. Our selection of such low ages as 103 (compared with the English Life ultimate ages) was largely guided by the very few cases of proved centenarians which Mr. T. E. Young, F.I.A., was able to trace in his recent work "On Centenarians."

(21). In the main body of the table the values of p_x were calculated from the values of d_x and L_x , obtained from the quinquennial groups in strict accordance with Milne's method. In the application of the method to the infantile ages, there is room for a marked difference of opinion as to the value of the initial or entrance ordinate L_0 or d_0 , as the case may be; yet our experience showed us that, while working separately with the parallelograms, although we might differ very materially as to the entrance ordinate, yet after passing a few stages along the journey, the curves obtained independently, were for all practical purposes identical. The values of $L-d$ for ages 0-4 are shown in the diagrams, the tops of the ordinates being joined by straight lines instead of a curve, but they do not appear in Table K.

The values of q_0, q_1, q_2, q_3, q_4 , were obtained by examining the number of births as given in the returns of the Registrars-General and the number of deaths registered in the corresponding period. We assumed that any gain by immigration of infants was neutralized by the emigration. The number of deaths at the various ages in the period under review is as given in Tables F and G.

Thus, 19,714 males died at completed age 0 during the four years 1890-1893; the number at risk was taken as the sum of one-half the births in the previous year 1888, all the births in 1889, 1890, 1891, and half of the births in 1892, in all a total of 156,217. The fraction $\frac{19,714}{156,217} = q_0$. Similarly, there were 4,049 deaths at completed age 1, the number at risk was the number of survivors of half the births in 1887, all the births in

1888, 1889, 1890, and half the births in 1891, a total of 153,087. The fraction $\frac{4,049}{153,087} = q_1 \times p_0$. Pursuing the same

train of argument, we obtained the values $\frac{1,548}{148,918} = q_2 \times p_0 \times p_1$,

$\frac{1,024}{144,342} = q_3 \times p_0 \times p_1 \times p_2$, and $\frac{815}{139,575} = q_4 \times p_0 \times p_1 \times p_2 \times p_3$.

From these equations the values of p_0, p_1, p_2, p_3, p_4 , were immediately obtained.

In tacking these values on to the values of p_5, p_6 , &c., obtained by Milne's process, a certain roughness or jolt at the junction might not unnaturally have been looked for. In the female table, no such roughness was experienced, as the Pell Values $p_0 - p_4$ joined on so smoothly with the Milne Values p_5 onwards as to form a series from which the deduced values $d_0, d_1, \dots d_{10}$, ran in such orderly progression as to require no further adjustment of any kind.

In the male table, the junction was not so perfect. The requisite smoothness of junction was simply effected by taking the Pell Values p_0, p_1, p_2, p_3 , ignoring the value of p_4 , and then continuing the series p_4, p_5 , &c., with the Milne Values.

(22). From the populations and deaths given in Table K, the unadjusted values in the mortality table were derived by use of the formula

The Unadjusted
Mortality
Table Values.

$$\lambda p_x = \lambda 2 \overline{L_x} - d_x - \lambda 2 \overline{L_x} + d_x.$$

The values of λl_x were obtained by successive addition of λp_x to the radix, and the corresponding values of l_x were taken out and differenced to give d_x . With the exception of the values for the advanced ages, the function m_x was not calculated.

(23). It may be remembered that the function m_x was selected by Mr. BurrIDGE in his Australian Table for his graduation which was made by the graphic method. The care expended over our population and deaths curves brought its reward in the shape of results which needed no drastic method of graduation, and we, therefore, decided to employ Mr. Woolhouse's well-known formula in place of a graphic graduation of q_x .

The function selected was d_x and the method used was that of the values copied on to slips—one in inverted order. The original and adjusted values, with the variation and accumulated variation, are given in Tables L and M.

TABLE L.—*Showing Unadjusted and Adjusted Values of d_x ; also the Variation and Accumulated Variation at each Age (Males).*

Age x	l_x Unadjusted	d_x Unadjusted	d_x Adjusted	Variation	Accumulated Variation	Age x
0	100,000	12,620	12,620	...		0
1	87,380	2,645	2,645			1
2	84,735	1,040	1,040			2
3	83,695	709	709			3
4	82,986	567	567			4
5	82,419	441	441			5
6	81,978	360	360			6
7	81,618	300	300			7
8	81,318	256	256			8
9	81,062	228	228			9
10	80,834	212	209	— 3	— 3	10
11	80,622	191	193	+ 2	— 1	11
12	80,431	187	193	+ 6	+ 5	12
13	80,244	198	200	+ 2	+ 7	13
14	80,046	216	215	— 1	+ 6	14
15	79,830	236	237	+ 1	+ 7	15
16	79,594	261	262	+ 1	+ 8	16
17	79,333	292	288	— 4	+ 4	17
18	79,041	321	314	— 7	— 3	18
19	78,720	343	340	— 3	— 6	19
20	78,377	363	365	+ 2	— 4	20
21	78,014	385	389	+ 4	0	21
22	77,629	408	412	+ 4	+ 4	22
23	77,221	432	435	+ 3	+ 7	23
24	76,789	459	455	— 4	+ 3	24
25	76,330	481	472	— 9	— 6	25
26	75,849	492	485	— 7	— 13	26
27	75,357	497	494	— 3	— 16	27
28	74,860	498	501	+ 3	— 13	28
29	74,362	501	508	+ 7	— 6	29
30	73,861	514	518	+ 4	— 2	30
31	73,347	529	531	+ 2	0	31
32	72,818	549	549	0	0	32
33	72,269	568	570	+ 2	+ 2	33
34	71,701	591	595	+ 4	+ 6	34
35	71,110	622	621	— 1	+ 5	35
36	70,488	652	649	— 3	+ 2	36
37	69,836	674	675	+ 1	+ 3	37
38	69,162	703	700	— 3	0	38
39	68,459	721	722	+ 1	+ 1	39
40	67,738	754	741	— 13	— 12	40
41	66,984	766	759	— 7	— 19	41
42	66,218	773	777	+ 4	— 15	42
43	65,445	790	799	+ 9	— 6	43
44	64,655	813	826	+ 13	+ 7	44
45	63,842	855	859	+ 4	+ 11	45
46	62,987	896	897	+ 1	+ 12	46
47	62,091	942	938	— 4	+ 8	47
48	61,149	986	979	— 7	+ 1	48
49	60,163	1,024	1,019	— 5	— 4	49
50	59,139	1,060	1,057	— 3	— 7	50
51	58,079	1,095	1,093	— 2	— 9	51

TABLE L—(continued).

Age x	l_x Ungraduated	d_x Ungraduated	d_x Graduated	Variation	Accumulated Variation	Age x
52	56,984	1,127	1,129	+ 2	- 7	52
53	55,857	1,161	1,167	+ 6	- 1	53
54	54,696	1,206	1,206	0	- 1	54
55	53,490	1,248	1,249	+ 1	0	55
56	52,242	1,294	1,295	+ 1	+ 1	56
57	50,948	1,346	1,343	- 3	- 2	57
58	49,602	1,396	1,392	- 4	- 6	58
59	48,206	1,440	1,444	+ 4	- 2	59
60	46,766	1,493	1,499	+ 6	+ 4	60
61	45,273	1,556	1,555	- 1	+ 3	61
62	43,717	1,619	1,613	- 6	- 3	62
63	42,098	1,669	1,675	+ 6	+ 3	63
64	40,429	1,723	1,740	+ 17	+ 20	64
65	38,706	1,798	1,799	+ 1	+ 21	65
66	36,908	1,857	1,857	0	+ 21	66
67	35,051	1,909	1,906	- 3	+ 18	67
68	33,142	1,951	1,943	- 8	+ 10	68
69	31,191	1,970	1,962	- 8	+ 2	69
70	29,221	2,007	1,965	- 42	- 40	70
71	27,214	1,958	1,954	- 4	- 44	71
72	25,256	1,911	1,935	+ 24	- 20	72
73	23,345	1,876	1,917	+ 41	+ 21	73
74	21,469	1,866	1,900	+ 34	+ 55	74
75	19,603	1,889	1,877	- 12	+ 43	75
76	17,714	1,877	1,846	- 31	+ 12	76
77	15,837	1,794	1,801	+ 7	+ 19	77
78	14,043	1,745	1,724	- 21	- 2	78
79	12,298	1,697	1,621	- 76	- 78	79
80	10,601	1,476	1,502	+ 26	- 52	80
81	9,125	1,336	1,368	+ 32	- 20	81
82	7,789	1,213	1,225	+ 12	- 8	82
83	6,576	1,082	1,091	+ 9	+ 1	83
84	5,494	962.9	963.9	+ 1	+ 2	84
85	4,531.1	844.4	842.2	- 2.2	- .2	85
86	3,686.7	733.4	728.7	- 4.7	- 4.9	86
87	2,953.3	624.3	624.1	- .2	- 5.1	87
88	2,329.0	520.5	525.4	+ 4.9	- .2	88
89	1,808.5	430.9	433.6	+ 2.7	+ 2.5	89
90	1,377.6	358.2	351.2	- 7	- 4.5	90
91	1,019.4	273.7	278.2	+ 4.5	0	91
92	745.7	212.7	212.7	.	.	92
93	533.0	161.3	161.3	.	.	93
94	371.7	120.9	120.9	.	.	94
95	250.8	87.5	87.5	.	.	95
96	163.3	60.8	60.8	.	.	96
97	102.5	41.0	41.0	.	.	97
98	61.5	26.5	26.5	.	.	98
99	35.0	17.0	17.0	.	.	99
100	18.0	9.3	9.3	.	.	100
101	8.7	5.0	5.0	.	.	101
102	3.7	2.6	2.6	.	.	102
103	1.1	1.1	1.1	.	.	103

TABLE M.—*Showing Unadjusted and Adjusted Values of d_x , also the Variation and Accumulated Variation at each Age (Females).*

Age x	l_x Ungraduated	d_x Ungraduated	d_x Graduated	Variation	Accumulated Variation	Age x
0	100,000	11,125	11,125	...	...	0
1	88,875	2,655	2,655	...	...	1
2	86,220	984	984	...	...	2
3	85,236	673	673	...	...	3
4	84,563	516	516	...	...	4
5	84,047	388	388	...	...	5
6	83,659	330	330	...	...	6
7	83,329	284	284	...	...	7
8	83,045	250	250	...	...	8
9	82,795	217	217	...	...	9
10	82,578	184	189	+ 5	+ 5	10
11	82,394	174	177	+ 3	+ 8	11
12	82,220	173	176	+ 3	+ 11	12
13	82,047	181	186	+ 5	+ 16	13
14	81,866	199	203	+ 4	+ 20	14
15	81,667	229	227	- 2	+ 18	15
16	81,438	259	255	- 4	+ 14	16
17	81,179	289	284	- 5	+ 9	17
18	80,890	314	310	- 4	+ 5	18
19	80,576	339	334	- 5	0	19
20	80,237	358	354	- 4	- 4	20
21	79,879	372	373	+ 1	- 3	21
22	79,507	387	389	+ 2	- 1	22
23	79,120	402	406	+ 4	+ 3	23
24	78,718	422	424	+ 2	+ 5	24
25	78,296	439	443	+ 4	+ 9	25
26	77,857	462	462	0	+ 9	26
27	77,395	485	481	- 4	+ 5	27
28	76,910	500	499	- 1	+ 4	28
29	76,410	518	516	- 2	+ 2	29
30	75,892	532	532	0	+ 2	30
31	75,360	548	548	0	+ 2	31
32	74,812	563	564	+ 1	+ 3	32
33	74,249	578	581	+ 3	+ 6	33
34	73,671	593	599	+ 6	+ 12	34
35	73,078	619	619	0	+ 12	35
36	72,459	641	638	- 3	+ 9	36
37	71,818	661	657	- 4	+ 5	37
38	71,157	675	674	- 1	+ 4	38
39	70,482	691	689	- 2	+ 2	39
40	69,791	700	702	+ 2	+ 4	40
41	69,091	711	714	+ 3	+ 7	41
42	68,380	725	724	- 1	+ 6	42
43	67,655	735	734	- 1	+ 5	43
44	66,920	744	743	- 1	+ 4	44
45	66,176	752	751	- 1	+ 3	45
46	65,424	756	759	+ 3	+ 6	46
47	64,668	769	767	- 2	+ 4	47
48	63,899	778	774	- 4	0	48
49	63,121	791	785	- 6	- 6	49
50	62,330	794	800	+ 6	0	50
51	61,536	820	822	+ 2	+ 2	51

TABLE M—(continued).

Age x	l_x Ungraduated	d_x Ungraduated	d_x Graduated	Variation	Accumulated Variation	Age x
52	60,716	847	853	+ 6	+ 8	52
53	59,869	880	893	+ 13	+ 21	53
54	58,989	935	941	+ 6	+ 27	54
55	58,051	993	996	+ 3	+ 30	55
56	57,061	1,063	1,052	- 11	+ 19	56
57	55,998	1,123	1,106	- 17	+ 2	57
58	54,875	1,164	1,155	- 9	- 7	58
59	53,711	1,200	1,199	- 1	- 8	59
60	52,511	1,242	1,240	- 2	- 10	60
61	51,269	1,287	1,282	- 5	- 15	61
62	49,982	1,328	1,330	+ 2	- 13	62
63	48,654	1,384	1,389	+ 5	- 8	63
64	47,270	1,442	1,463	+ 21	+ 13	64
65	45,828	1,537	1,556	+ 19	+ 32	65
66	44,291	1,648	1,665	+ 17	+ 49	66
67	42,643	1,776	1,785	+ 9	+ 58	67
68	40,867	1,912	1,911	- 1	+ 57	68
69	38,955	2,042	2,029	- 13	+ 44	69
70	36,913	2,143	2,128	- 15	+ 29	70
71	34,770	2,233	2,202	- 31	- 2	71
72	32,537	2,256	2,247	- 9	- 11	72
73	30,281	2,266	2,263	- 3	- 14	73
74	28,015	2,268	2,252	- 16	- 30	74
75	25,747	2,216	2,226	+ 10	- 20	75
76	23,531	2,158	2,187	+ 29	+ 9	76
77	21,373	2,122	2,140	+ 18	+ 27	77
78	19,251	2,065	2,084	+ 19	+ 46	78
79	17,186	2,041	2,015	- 26	+ 20	79
80	15,145	1,957	1,928	- 29	- 9	80
81	13,188	1,834	1,822	- 12	- 21	81
82	11,354	1,698	1,694	- 4	- 25	82
83	9,656	1,546	1,551	+ 5	- 20	83
84	8,110	1,390	1,397	+ 7	- 13	84
85	6,720	1,241	1,238	- 3	- 16	85
86	5,479	1,075	1,080	+ 5	- 11	86
87	4,404	923.3	927.2	+ 3.9	- 7.1	87
88	3,480.7	781.9	781.9	0	- 7.1	88
89	2,698.8	642.1	647.7	+ 5.6	- 1.5	89
90	2,056.7	522.0	523.5	+ 1.5	0	90
91	1,534.7	413.2	413.2			91
92	1,121.5	322.8	322.8			92
93	798.7	247.5	247.5			93
94	551.2	180.7	180.7			94
95	370.5	129.5	129.5	...	...	95
96	241.0	91.2	91.2	...	...	96
97	149.8	60.0	60.0	...	...	97
98	89.8	37.9	37.9	...	...	98
99	51.9	24.0	24.0	...	...	99
100	27.9	14.5	14.5	...	...	100
101	13.4	8.4	8.4	...	...	101
102	5.0	3.6	3.6	...	...	102
103	1.4	1.4	1.4	...	...	103

It will be seen, from an inspection of these, that the unadjusted values were accepted for the first 10 values in each table, and for ages 92 to the end in the males table, and ages 91 to the end in the females table. It will be remembered that to obtain these final values, a graduated p_x was originally used and the final graduation was only carried far enough to completely eliminate any want of smoothness at the original junction values.

(24). The final values of the mortality tables will be found in **The Final Mortality Table.** Tables P and Q at the end of the paper, values of l_x , d_x , p_x , and μ_x , being quoted. The column of p_x was found by differencing λ_x and finding the corresponding natural numbers. The function e_x was not tabulated, as we regarded it as too dangerous a weapon in the hands of an unskilled workman, and where annuity-values are given, as in this case, it is of little or no value as a function for comparison.

(25). A comparison of the values of p_x with those of other **Comparison with other Tables.** tables may be of some interest, and quinquennial values of our Australian tables (1891) with those of Mr. BurrIDGE (1881–1891) and those of the English Life Table No. III are given in the following Table N, while a graphic comparison at annual intervals is given in Diagrams V and VI of the Appendix.

In these diagrams, for the purpose of comparison, the Australian tables have been taken as the standards, and the values of p_x given therein are represented by the straight line $\cdot000$ to $\cdot000$, while the variations in the values of p_x as given in Mr. BurrIDGE's Tables 1871–1881, and the English Life Tables, No. III, are shown by the dotted and continuous lines respectively; thus, at age 55, in Diagram V, the value of p_{55} (Australia, 1891) is $\cdot9766$. Mr. BurrIDGE's value differs from it by $\cdot0007$ in excess, being $\cdot9773$, and the English Life Table Value by $\cdot0011$ in defect being $\cdot9755$.

TABLE N.—*Comparison of the Values of p_x at Quinquennial Ages of the present Investigation with those of Mr. Burridge's Investigation, and those of the English Life Table No. III.*

Ages	AUSTRALIAN 1891		BURRIDGE 1871-1881		ENGLISH LIFE No. III		Ages
	Males	Females	Males	Females	Males	Females	
0	·8738	·8888	·8746	·8912	·8364	·8653	0
5	·9947	·9954	·9943	·9947	·9864	·9867	5
10	·9974	·9977	·9966	·9961	·9944	·9941	10
15	·9970	·9972	·9965	·9967	·9948	·9945	15
20	·9953	·9956	·9946	·9952	·9917	·9914	20
25	·9938	·9943	·9932	·9935	·9908	·9904	25
30	·9930	·9930	·9920	·9914	·9899	·9894	30
35	·9913	·9915	·9901	·9901	·9887	·9884	35
40	·9891	·9899	·9872	·9879	·9870	·9872	40
45	·9865	·9887	·9842	·9870	·9846	·9857	45
50	·9821	·9872	·9805	·9863	·9812	·9838	50
55	·9766	·9828	·9773	·9827	·9755	·9790	55
60	·9680	·9764	·9656	·9746	·9675	·9711	60
65	·9535	·9660	·9546	·9668	·9541	·9589	65
70	·9327	·9423	·9352	·9522	·9327	·9394	70
75	·9040	·9136	·9043	·9134	·9012	·9103	75
80	·8594	·8725	·8755	·8799	·8582	·8698	80
85	·8140	·8161	·8200	·8327	·8029	·8169	85
90	·7416	·7457	·7498	·7641	·7358	·7517	90
95	·6511	·6505	·6657	·6842	·6586	·6756	95
100	·4833	·4803	·5797	·5977	·5741	·5913	100

TABLE O.—*Comparison of the Values of p_x at Quinquennial Ages of the present Investigation with those of the English Life Table No. III.*

Ages	AUSTRALIAN 1891		ENGLISH LIFE No. III		Ages
	Males	Females	Males	Females	
5	·00604	·00520	·01555	·01528	5
10	·00270	·00247	·00601	·00621	10
15	·00282	·00260	·00500	·00538	15
20	·00450	·00429	·00800	·00829	20
25	·00608	·00554	·00912	·00956	25
30	·00694	·00691	·01002	·01053	30
35	·00855	·00833	·01119	·01154	35
40	·01080	·00997	·01285	·01272	40
45	·01318	·01129	·01525	·01420	45
50	·01756	·01270	·01858	·01612	50
55	·02294	·01668	·02423	·02060	55
60	·03146	·02322	·03202	·02830	60
65	·04576	·03288	·04525	·04041	65
70	·06729	·05648	·06689	·05999	70
75	·09667	·08695	·09991	·09020	75
80	·14646	·13055	·14729	·13418	80
85	·19914	·19573	·21205	·19509	85
90	·28422	·28355	·29708	·27609	90
95	·41092	·41221	·40564	·37998	95
100	·70648	·66667	·53490	·50899	100

V.—THE FORCE OF MORTALITY.

(26). This function was calculated direct from the d_x column of the adjusted mortality table by means of the formula

Algebraical
Calculation.

$$\mu_x = \frac{7(d_{x-1} + d_x) - (d_{x-2} + d_{x+1})}{12l_x}.$$

Owing to the fact that this table had been adjusted by Woolhouse's formula, the values of μ_x obtained ran smoothly for all ages from 12 onwards: for the ages under 12 the values were not satisfactory, inasmuch as they formed a series varying but slowly, while the corresponding values of q_x were changing rapidly. The values of d_x did not constitute a series whose fourth differences were sensibly constant, and consequently the formula did not apply. The simpler formula,

$$\mu_x = \frac{d_{x-1} + d_x}{2l_x},$$

would probably have given better results at these young ages.

(27). In preference to using the last-named method, recourse was had once more to a graphic process.

Geometrical
Calculation.

From the definition, we have

$$\mu_x = -\frac{d\lambda_{l_x}}{d_x} = -\frac{1}{l_x} \cdot \frac{dl_x}{d_x},$$

whence

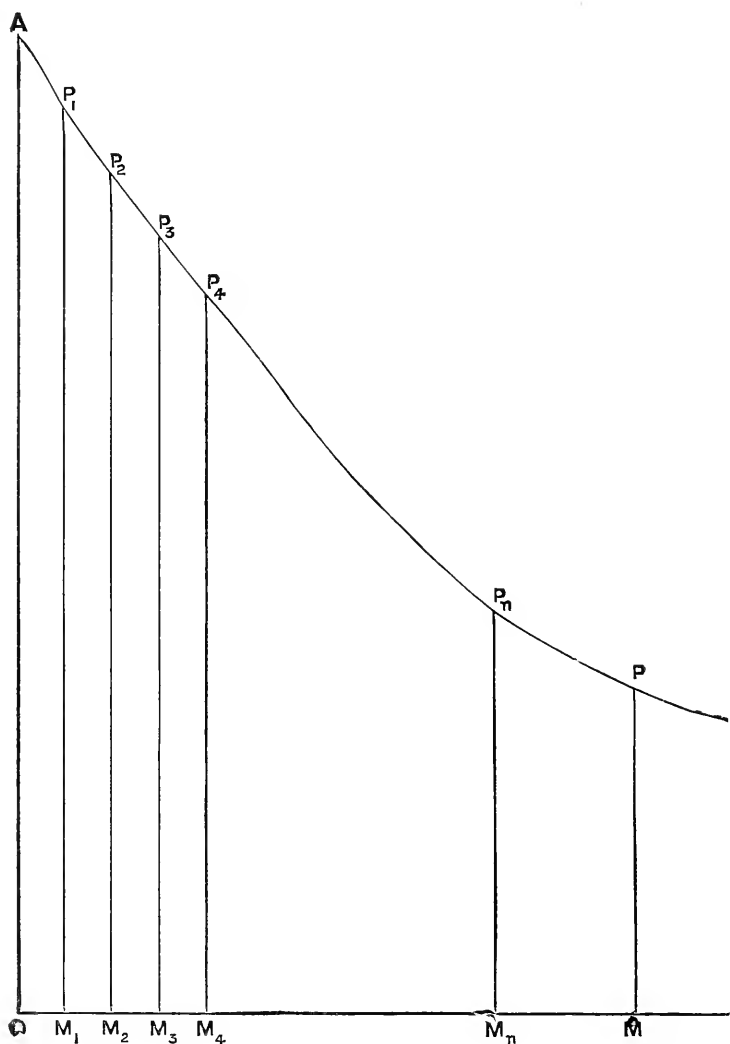
$$\mu_x \cdot l_x = -\frac{dl_x}{d_x}$$

Integrating this equation between the limits x and $x+1$, we have

$$\int \mu_x l_x dx = l_x - l_{x+1} = d_x.$$

Parallelograms whose areas represented d_0, d_1, \dots &c., as given in the adjusted mortality table, were laid off upon the table, and a curve was then traced through them in the same method as that used by Milne. To ensure a close approximation to the area of the figure cut off by the curved line, each year was represented by the space covered by twelve ordinates, and thus, in the following diagram, the area between the curved line A P, the axis O M, and the ordinates O A . M P, was taken as

equivalent to the sum of the areas of the twelve trapeziums AM_1 , P_1M_2 , P_2M_3 , \dots &c. With the curve thus accurately drawn, any ordinate (*e.g.*, P_nM_n) represents μl for the corresponding age $x+n$. Ordinary division then gives the desired value of μ .



(28). To obtain $\mu_0 l_0$, or the starting-point of the curve, we had perforce to use our own discretion. We confess, at once, that we were unable to obtain a satisfactory value of μ_0 by any process algebraic or geometric. An approximation to it is, however, given in both tables, but printed in different type. The values given are really

$$12 \times \left| \frac{1}{1\frac{1}{2}} q_0 \right.$$

Of recent years the Government Statistician in New South Wales has supplied a valuable table, showing, for both males and females, the numbers dying in each month of the first year after birth, while the Department in Victoria has for many years past supplied a table showing the numbers dying at ages, less than one month, over one month and less than three months, over three months and less than six months, and over six months and less than one year. From an examination of these tables, values of $\left| \frac{1}{1\frac{1}{2}} q_0 \right.$, $\left| \frac{1}{1\frac{1}{2}} \frac{1}{1\frac{1}{2}} q_0 \right.$, $\left| \frac{1}{4\frac{1}{4}} q_0 \right.$, $\left| \frac{1}{2\frac{1}{2}} q_0 \right.$, were deduced and used as guiding values in tracing the $\mu_x l_x$ curve. It will be noticed that the approximate values of μ_0 as given considerably exceed the value of μ_0 given in the table at the end of the Institute Text-Book.

When the Statisticians extend the scope of their tables to show the numbers dying in the first week or the first day of their age, we may be able to get a closer idea of the actual value of μ_0 . With our present data, the curve bends upwards so very rapidly in passing from ages 2-3 months to 0-1 month as to render the final value very much a matter of speculation within certain limits, especially in the case of general population tables, which, as yet, have not been found to accord with any algebraic formula, such as those of Gompertz or Makeham.

(29). Incidentally it may be here mentioned that Milne's method of distributing population is an elegant geometrical demonstration of the well-known approximate formula

$$m_x = \mu_{x+\frac{1}{2}}.$$

In Milne's graduation it is assumed that the area between the curve, the axis of x , and the ordinates corresponding to ages x and $x+1$ is equal to the area of the rectangle contained by the ordinate corresponding to the age $x+\frac{1}{2}$ and the intercept of the x axis between the ordinates for age x and $x+1$. If then the curve being traced is the d_x curve, the former area is d_x , the

rectangle representing it is approximately $\mu_{x+\frac{1}{2}}/l_{x+\frac{1}{2}}$, the intercept on the x axis being taken as unity. We get at once that

$$\mu_{x+\frac{1}{2}} = \frac{d_x}{l_{x+\frac{1}{2}}} = \frac{d_x}{L_x} = m_x.$$

VI.—MONETARY VALUES.

(30). No attempt has been made to form a complete set of monetary tables. Annuity-values have, however, been calculated for each of the tables at what may be considered the standard rate of interest in Australia, namely, $3\frac{1}{2}$ per-cent. These were calculated by the continuous formula

$$\lambda a_x = \lambda r p_x + \lambda(1 + a_{x+1}).$$

Subsequently, the tables being "population" tables, these values were turned into continuous values by the addition of $.5 - \frac{\mu_x + \delta}{12}$, and the results will be found in Table R, at the finish, which may be taken as fundamental values for other calculations.

Should the results at which we have arrived receive the imprimatur of our London brethren, we will be glad at some future date to furnish more complete monetary tables to the *Journal of the Institute*, including specimen policy-values at different ages.

TABLE P.—*The Mortality Table (Males).*

x	l_x	d_x	p_x	μ_x	x
0	100,000	12,620	·87380	·47185	0
1	87,380	2,645	·96973	·05837	1
2	84,735	1,040	·98773	·01841	2
3	83,695	709	·99152	·00908	3
4	82,986	567	·99317	·00766	4
5	82,419	441	·99465	·00604	5
6	81,978	360	·99561	·00482	6
7	81,618	300	·99632	·00402	7
8	81,318	256	·99685	·00338	8
9	81,062	228	·99719	·00296	9
10	80,834	209	·99742	·00270	10
11	80,625	193	·99761	·00249	11
12	80,432	193	·99760	·00235	12
13	80,239	200	·99751	·00243	13
14	80,039	215	·99731	·00257	14
15	79,824	237	·99703	·00282	15
16	79,587	262	·99671	·00313	16
17	79,325	288	·99637	·00347	17
18	79,037	314	·99603	·00381	18
19	78,723	340	·99568	·00416	19
20	78,383	365	·99534	·00450	20
21	78,018	389	·99501	·00482	21
22	77,629	412	·99469	·00516	22
23	77,217	435	·99437	·00549	23
24	76,782	455	·99407	·00580	24
25	76,327	472	·99382	·00608	25
26	75,855	485	·99361	·00632	26
27	75,370	494	·99345	·00650	27
28	74,876	501	·99331	·00665	28
29	74,375	508	·99317	·00678	29
30	73,867	518	·99299	·00694	30
31	73,349	531	·99276	·00714	31
32	72,818	549	·99246	·00741	32
33	72,269	570	·99211	·00773	33
34	71,699	595	·99170	·00812	34
35	71,104	621	·99127	·00855	35
36	70,483	649	·99079	·00901	36
37	69,834	675	·99034	·00948	37
38	69,159	700	·98988	·00995	38
39	68,459	722	·98945	·01039	39
40	67,737	741	·98906	·01080	40
41	66,996	759	·98867	·01120	41
42	66,237	777	·98827	·01159	42
43	65,460	799	·98779	·01203	43
44	64,661	826	·98723	·01255	44
45	63,835	859	·98654	·01318	45
46	62,976	897	·98576	·01393	46
47	62,079	938	·98489	·01478	47
48	61,141	979	·98399	·01568	48
49	60,162	1,019	·98306	·01661	49
50	59,143	1,057	·98213	·01756	50
51	58,086	1,093	·98119	·01851	51
52	56,993	1,129	·98019	·01949	52
53	55,864	1,167	·97911	·02050	53
54	54,697	1,206	·97795	·02169	54

TABLE P—(continued)

x	l_x	d_x	p_x	μ_x	x
55	53,491	1,249	·97665	·02294	55
56	52,242	1,295	·97521	·02434	56
57	50,947	1,343	·97361	·02589	57
58	49,604	1,392	·97194	·02750	58
59	48,212	1,444	·97005	·02940	59
60	46,768	1,499	·96795	·03146	60
61	45,269	1,555	·96565	·03373	61
62	43,714	1,613	·96310	·03622	62
63	42,101	1,675	·96022	·03904	63
64	40,426	1,740	·95696	·04224	64
65	38,686	1,799	·95350	·04576	65
66	36,887	1,857	·94966	·04958	66
67	35,030	1,906	·94559	·05376	67
68	33,124	1,943	·94134	·05818	68
69	31,181	1,962	·93708	·06271	69
70	29,219	1,965	·93275	·06729	70
71	27,254	1,954	·92830	·07197	71
72	25,300	1,935	·92352	·07688	72
73	23,365	1,917	·91795	·08242	73
74	21,448	1,900	·91141	·08900	74
75	19,548	1,877	·90398	·09667	75
76	17,671	1,846	·89554	·10545	76
77	15,825	1,801	·88619	·11547	77
78	14,024	1,724	·87707	·12602	78
79	12,300	1,621	·86821	·13626	79
80	10,679	1,502	·85935	·14646	80
81	9,177	1,368	·85093	·15659	81
82	7,809	1,225	·84313	·16603	82
83	6,584	1,091	·83430	·17568	83
84	5,493	963·9	·82452	·18686	84
85	4,529·1	812·2	·81405	·19914	85
86	3,686·9	728·7	·80235	·21265	86
87	2,958·2	624·1	·78903	·22823	87
88	2,334·1	525·4	·77490	·24578	88
89	1,808·7	433·6	·76027	·26436	89
90	1,375·1	351·2	·74460	·28422	90
91	1,023·9	278·2	·72829	·30598	91
92	745·7	212·7	·71477	·32674	92
93	533·0	161·3	·69737	·34692	93
94	371·7	120·9	·67474	·37557	94
95	250·8	87·5	·65112	·41092	95
96	163·3	60·8	·62768	·44713	96
97	102·5	41·0	·60000	·48667	97
98	61·5	26·5	·56911	·53482	98
99	35·0	17·0	·51429	·60524	99
100	18·0	9·3	·48333	·70618	100
101	8·7	5·0	·42529	·77107	101
102	3·7	2·6	·29730	·96396	102
103	1·1	1·1	·00000	1·58333	103

TABLE Q.—*The Mortality Table (Females).*

x	l_x	d_x	p_x	μ_x	x
0	100,000	11,125	·88875	·37728	0
1	88,875	2,655	·97013	·06031	1
2	86,220	981	·98859	·01461	2
3	85,236	673	·99210	·00892	3
4	84,563	516	·99390	·00701	4
5	84,047	388	·99539	·00520	5
6	83,659	330	·99605	·00424	6
7	83,329	284	·99659	·00366	7
8	83,045	250	·99699	·00318	8
9	82,795	217	·99738	·00280	9
10	82,578	189	·99771	·00247	10
11	82,389	177	·99785	·00222	11
12	82,212	176	·99786	·00213	12
13	82,036	186	·99773	·00221	13
14	81,850	203	·99752	·00237	14
15	81,647	227	·99722	·00260	15
16	81,420	255	·99687	·00296	16
17	81,165	284	·99650	·00331	17
18	80,881	310	·99617	·00366	18
19	80,571	334	·99586	·00400	19
20	80,237	354	·99559	·00429	20
21	79,883	373	·99533	·00456	21
22	79,510	389	·99511	·00479	22
23	79,121	406	·99487	·00502	23
24	78,715	424	·99461	·00527	24
25	78,291	443	·99434	·00554	25
26	77,848	462	·99406	·00581	26
27	77,386	481	·99379	·00609	27
28	76,905	499	·99351	·00637	28
29	76,406	516	·99325	·00664	29
30	75,890	532	·99299	·00691	30
31	75,358	548	·99273	·00717	31
32	74,810	564	·99246	·00743	32
33	74,246	581	·99217	·00771	33
34	73,665	599	·99187	·00801	34
35	73,066	619	·99153	·00833	35
36	72,447	638	·99120	·00868	36
37	71,809	657	·99085	·00902	37
38	71,152	674	·99053	·00936	38
39	70,478	689	·99022	·00967	39
40	69,789	702	·98994	·00997	40
41	69,087	714	·98967	·01025	41
42	68,373	724	·98941	·01052	42
43	67,649	734	·98915	·01078	43
44	66,915	743	·98890	·01104	44
45	66,172	751	·98865	·01129	45
46	65,421	759	·98840	·01154	46
47	64,662	767	·98814	·01180	47
48	63,895	774	·98789	·01206	48
49	63,121	785	·98756	·01234	49
50	62,336	800	·98717	·01270	50
51	61,536	822	·98664	·01316	51
52	60,714	853	·98595	·01377	52
53	59,861	893	·98508	·01456	53
54	58,968	941	·98404	·01553	54

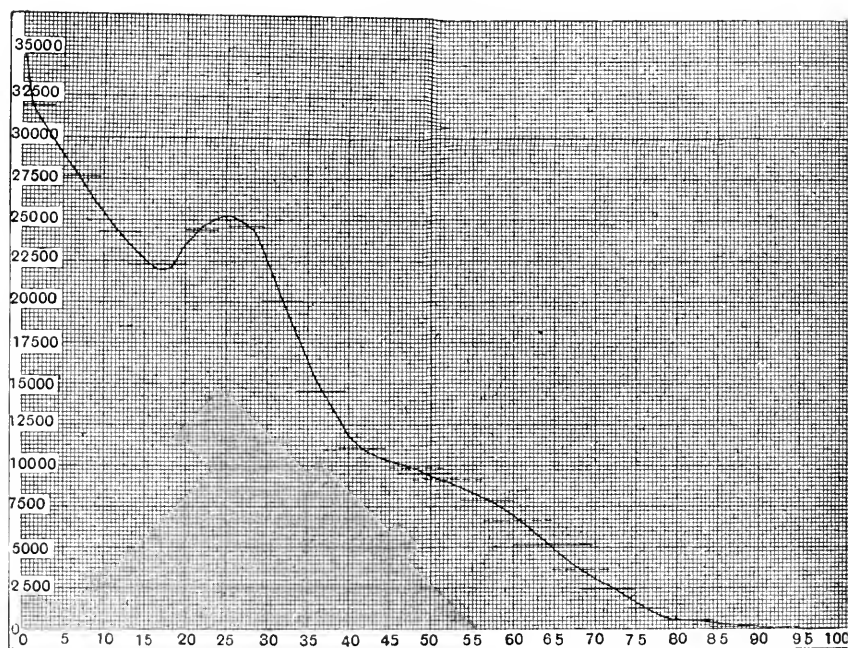
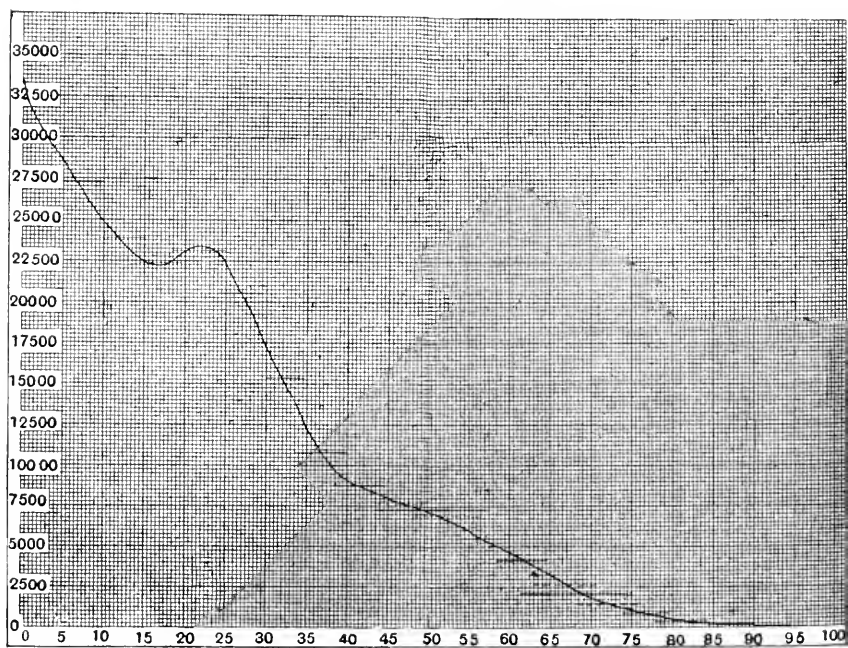
TABLE Q—(continued).

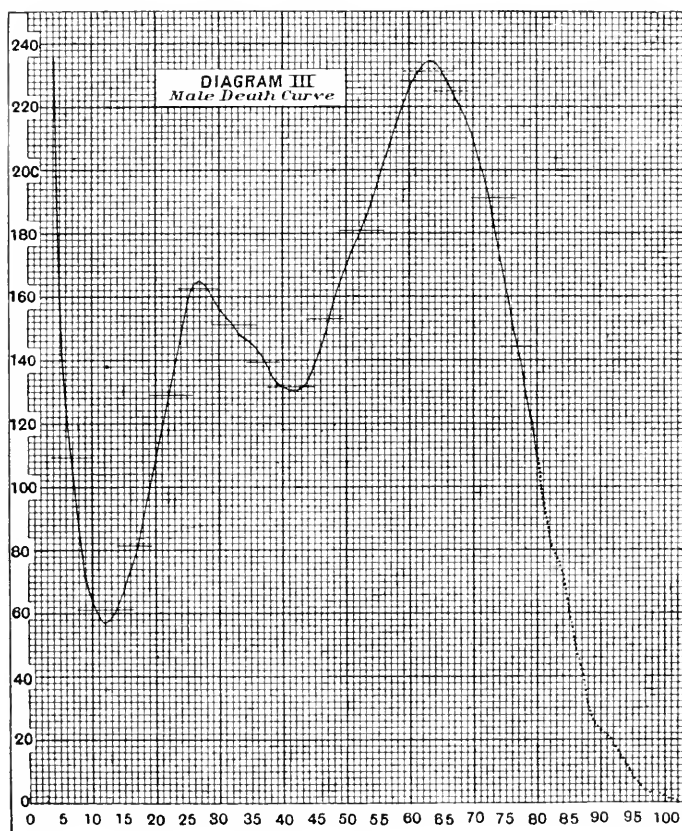
x	l_x	d_x	p_x	μ_x	x
55	58,027	996	·98284	·01668	55
56	57,031	1,052	·98155	·01796	56
57	55,979	1,106	·98024	·01929	57
58	54,873	1,155	·97895	·02062	58
59	53,718	1,199	·97768	·02192	59
60	52,519	1,240	·97639	·02322	60
61	51,279	1,282	·97500	·02458	61
62	49,997	1,330	·97340	·02609	62
63	48,667	1,389	·97146	·02789	63
64	47,278	1,463	·96906	·03010	64
65	45,815	1,556	·96604	·03288	65
66	44,259	1,665	·96238	·03634	66
67	42,594	1,785	·95809	·04047	67
68	40,809	1,911	·95317	·04529	68
69	38,898	2,029	·94784	·05070	69
70	36,869	2,128	·94228	·05648	70
71	34,741	2,202	·93662	·06245	71
72	32,539	2,247	·93095	·06851	72
73	30,292	2,263	·92529	·07460	73
74	28,029	2,252	·91965	·08067	74
75	25,777	2,226	·91364	·08695	75
76	23,551	2,187	·90714	·09377	76
77	21,364	2,140	·89983	·10134	77
78	19,224	2,081	·89159	·10996	78
79	17,140	2,015	·88244	·11973	79
80	15,125	1,928	·87253	·13055	80
81	13,197	1,822	·86194	·14231	81
82	11,375	1,694	·85108	·15482	82
83	9,681	1,551	·83979	·16782	83
84	8,130	1,397	·82817	·18147	84
85	6,733	1,238	·81613	·19573	85
86	5,495	1,080	·80346	·21083	86
87	4,415	927·2	·78999	·22708	87
88	3,487·8	781·9	·77582	·24454	88
89	2,705·9	647·7	·76063	·26351	89
90	2,058·2	523·5	·74565	·28355	90
91	1,534·7	413·2	·73076	·30334	91
92	1,121·5	322·8	·71217	·32553	92
93	798·7	247·5	·69012	·35456	93
94	551·2	180·7	·67217	·38478	94
95	370·5	129·5	·65047	·41221	95
96	241·0	91·2	·62158	·45097	96
97	149·8	60·0	·59947	·49566	97
98	89·8	37·9	·57795	·52905	98
99	51·9	24·0	·53757	·57611	99
100	27·9	14·5	·48029	·66667	100
101	13·4	8·4	·37313	·82525	101
102	5·0	3·6	·28000	1·13500	102
103	1·4	1·4	·00000	1·58334	103

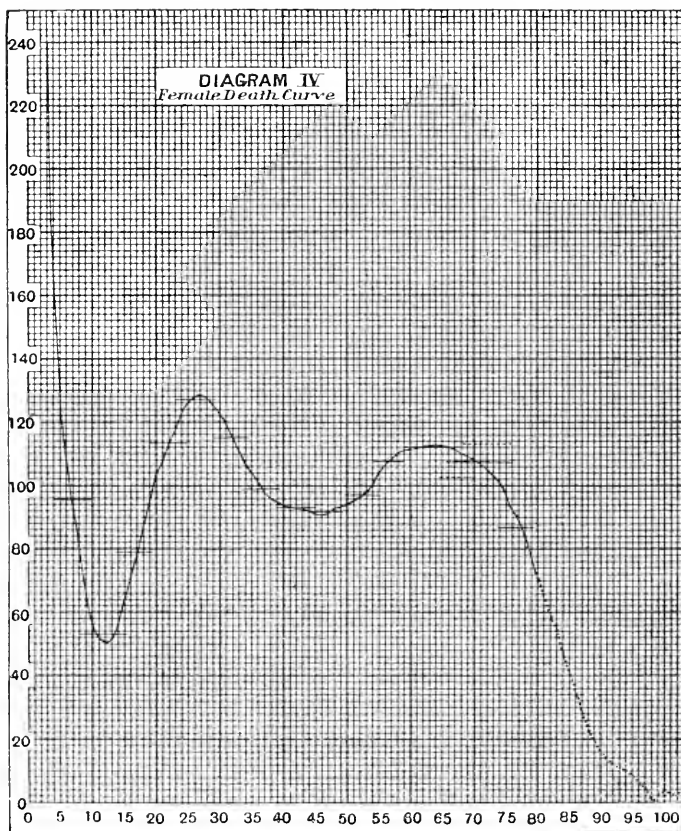
TABLE R.—*Values of \bar{a}_x at $3\frac{1}{2}$ per-cent, deduced from the Australian Mortality Tables, 1891.*

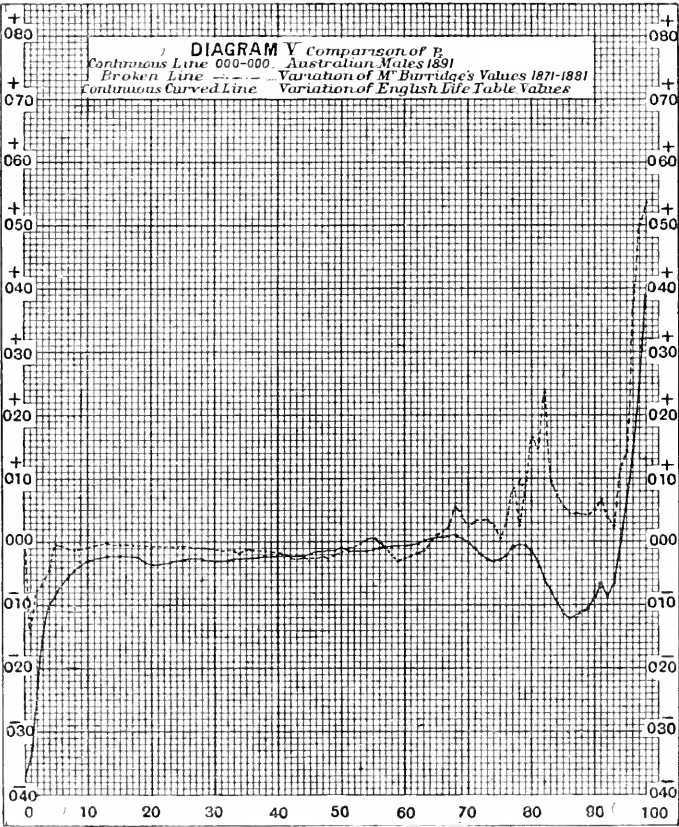
Age	Male	Female	Age	Male	Female
0	20·0376	20·6805	55	11·7916	12·8350
1	22·6842	23·0061	56	11·4663	12·4898
2	23·1812	23·5416	57	11·1388	12·1428
3	23·2677	23·6272	58	10·8095	11·7933
4	23·2662	23·6274	59	10·4786	11·4401
5	23·2254	23·5842	60	10·1469	11·0816
6	23·1475	23·5031	61	9·8153	10·7170
7	23·0438	23·4027	62	9·4845	10·3459
8	22·9190	23·2855	63	9·1555	9·9692
9	22·7772	23·1543	64	8·8298	9·5887
10	22·6220	23·0090	65	8·5093	9·2073
11	22·4558	22·8504	66	8·1942	8·8290
12	22·2789	22·6825	67	7·8859	8·4576
13	22·0955	22·5082	68	7·5846	8·0965
14	21·9072	22·3305	69	7·2899	7·7488
15	21·7163	22·1509	70	6·9999	7·4155
16	21·5243	21·9713	71	6·7130	7·0962
17	21·3321	21·7926	72	6·4277	6·7894
18	21·1399	21·6153	73	6·1439	6·4929
19	20·9476	21·4386	74	5·8642	6·2040
20	20·7551	21·2617	75	5·5924	5·9201
21	20·5623	21·0837	76	5·3313	5·6408
22	20·3686	20·9042	77	5·0847	5·3663
23	20·1738	20·7223	78	4·8557	5·0982
24	19·9779	20·5381	79	4·6416	4·8390
25	19·7799	20·3519	80	4·4392	4·5904
26	19·5790	20·1637	81	4·2465	4·3537
27	19·3739	19·9736	82	4·0596	4·1293
28	19·1634	19·7814	83	3·8727	3·9160
29	18·9469	19·5866	84	3·6873	3·7128
30	18·7239	19·3891	85	3·5046	3·5185
31	18·4951	19·1884	86	3·3243	3·3319
32	18·2608	18·9843	87	3·1479	3·1525
33	18·0222	18·7767	88	2·9787	2·9805
34	17·7798	18·5657	89	2·8170	2·8153
35	17·5343	18·3514	90	2·6616	2·6578
36	17·2860	18·1343	91	2·5132	2·5037
37	17·0350	17·9137	92	2·3712	2·3478
38	16·7809	17·6898	93	2·2213	2·1966
39	16·5232	17·4617	94	2·0676	2·0581
40	16·2608	17·2288	95	1·9199	1·9157
41	15·9930	16·9904	96	1·7758	1·7713
42	15·7191	16·7460	97	1·6265	1·6401
43	15·4389	16·4917	98	1·4707	1·4977
44	15·1529	16·2362	99	1·2984	1·3199
45	14·8622	15·9700	100	1·1523	1·1182
46	14·5677	15·6954	101	·9618	·8864
47	14·2706	15·4119	102	·7040	·6731
48	13·9713	15·1193	103	·3652	·3652
49	13·6699	14·8167			
50	13·3658	14·5045			
51	13·0586	14·1833			
52	12·7476	13·8540			
53	12·4326	13·5186			
54	12·1139	13·1784			

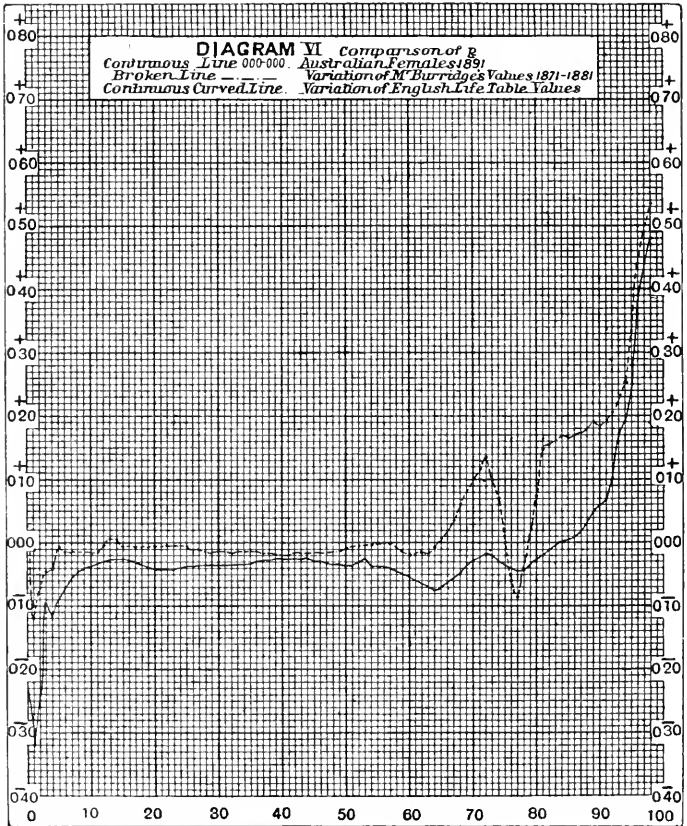
APPENDIX.

DIAGRAM I *Male Population Curve*DIAGRAM II *Female Population Curve*









DISCUSSION.

The PRESIDENT said that, as regarded the paper itself, it need ask for no indulgence by reason of its parentage, but could boldly claim to be considered on its own merits alone. Those who had studied it would agree with him that it was creditable, whether one considered the honest labour put into it, or its resourcefulness, or its clear setting out of the methods which had been used, or—not least of all—the integrity with which it was frankly admitted from time to time that some particular effort had failed. He would ask Mr. Baker to open the discussion.

Mr. H. J. BAKER said that as a junior Member of the Institute he felt considerable diffidence in venturing to express any opinion on a subject so difficult as that of the construction of mortality tables from census returns, and he only did so in the hope of eliciting information. At a time when their thoughts were turning to the approaching census of their own land, they could not fail to be interested in this able investigation into the mortality experience of a distant but very important part of the Empire. Life in Australia differed in so many respects from that to which one was accustomed in Great Britain, that it was interesting and instructive to compare the rates of mortality experienced in the two countries, and to trace the causes of the distinctive features of each, and their permanency or otherwise. Though many investigations had been made from time to time into the mortality experienced in various parts of the world, and amongst different classes of the community, there were still many points, both theoretical and practical, that deserved fuller discussion than they seemed to have received hitherto. The effect on the resulting tables of the different methods of construction did not appear to have been thoroughly examined; the influence of migration on the rate of mortality and the average age at death had not yet been completely investigated, and the best means of correcting census returns for errors in the statement of age would well bear further consideration. The method adopted by Milne in the construction of the Carlisle Table had been used in this investigation, though doubts had been expressed as to its applicability when the population did not increase uniformly. Probably there would be in such a case no serious error, so long as the deaths increased in about the same proportion as the population. The census of 1891 had been taken as the basis of the present investigation along with the registered deaths for the four years from 1 April 1889 to 31 March 1893. A mortality table should show, not so much the rate of mortality at a particular time, as the rates which had been, and which would be likely to be, experienced over a considerable period, and in the case of a population subject to considerable fluctuations, both in age distribution and in death rates, a better average would probably be maintained by utilizing two census returns (provided, of course, that the censuses had been taken with an equal degree of accuracy) and the deaths for the intervening period. The deaths in Victoria during the four years continually decreased, from 19,000 in 1890 to 16,000 in 1893, while the immigrants also diminished from 16,000 in 1890 until in 1893 there was a loss by emigration of over 6,000—the

immigration of 1890 and 1891 probably causing to some extent the fall in the death rate. It was noticeable, too, that the death rate in New South Wales had recently fallen to a remarkable extent; thus, from 1881 to 1890 the average death rate was 14·6 per 1,000, from 1886 to 1890 it was 13·7, from 1889 to 1893 it was 13·2, and from 1891 to 1895 it was 12·7 per 1,000, and this fall was only to a small extent caused by different age distribution. The immigrants had been assumed to be aged between 15 and 64, and to be distributed in proportion to the population at each age. This method was, however, not altogether satisfactory, as on the whole there would be a greater proportion of younger lives among the immigrants and of older lives among the emigrants than among the general population, and as the immigrants were considerably more numerous than the emigrants too many deaths would seem to have been allocated to the older ages. No allowance had been made for the migration of infants. In 1893 Mr. Dovey read, at the Insurance Institute of New South Wales, a paper "On the Rate of Mortality in New South Wales and Victoria", and in 1894 Mr. Duckworth submitted to the same Institute the results of his investigation into the rate of mortality in the two colonies. The bases of Mr. Dovey's calculations were the censuses of 1881 and 1891 and the deaths for 11 years (1881-1891), while Mr. Duckworth utilized the same census returns but took the deaths for 10 years (1881-1890). Mr. Dovey formed population and death curves by Milne's method, and for ages over 70 the values of p_x were taken from the English Life No. 3, p_{x-1} being adopted for females. Mr. Duckworth found the mean annual rate of mortality for the central age of quinquennial groups by dividing the mean annual deaths for each group by the mean population at those ages for the decennium, and graphically adjusted the results. For ages over 80 the English Life No. 3 value of p_x was taken with an addition of $2\frac{3}{4}$ per-cent. The two investigations gave extremely close results, the difference in the expectation of life in no case exceeding one-third of a year. The values of p_x given in tables P and Q were greater than Mr. Dovey's figures up to age 93 for males and age 70 for females; while a comparison with Mr. Burridge's investigation and the English Life Table No. 3 would be found in Table N. The complete expectations of life at age 0 were, by Mr. Burridge, males 46·5, females 49·6; by Mr. Dovey, males 47·8, females 50·7; and by the present investigation, males 49·1, females 52·1, showing an excess over Mr. Burridge's values of 2·6 and 2·5 years respectively. After age 50 the tables before them gave expectations of life greater than Mr. Burridge's values and less than Mr. Dovey's. Although the greater death rate per 1,000 in Victoria was to some extent accounted for by the fact that the average age of the population was higher than that of New South Wales (the Government Statistician estimating the average ages at the date of the last census as 25·6 and 23·9 years respectively), there seemed to be no doubt that the mortality experience of Victoria was heavier than that of New South Wales, and it would have been interesting to have had separate mortality tables for the two colonies. Mr. Duckworth gave separate figures for New South Wales and Victoria, showing a distinctly heavier rate of mortality in the latter, and by dividing the

adjusted deaths given in Table I for decennial groups of ages by the population living at those ages, he (Mr. Baker) found the difference to be still more marked in the present instance. The values of p_x were greater for females at all ages, and this distinctive feature of Australian life was caused almost entirely by the excessive mortality among males due to accident, negligence, and intemperance. The H^M Table was generally employed in Australian life office valuations, and it was a matter of extreme importance to determine to what extent it was safe to do so. The mortality experience of the Australian Mutual Provident Society had been investigated, but unfortunately the data at the older ages were hardly sufficient to give trustworthy results, and the same remark applied to the statistics of the colonies themselves. In the interesting paper submitted by Mr. Carment to the Second International Congress would be found a comparison of the H^M 4 per-cent values with those of the Australian Mutual Provident Society's 40 years' experience, and also with those based on Mr. Duckworth's figures. The Australian Mutual Provident values "are in almost every case less than the H^M ", while the values deduced from the table for New South Wales and Victoria "are for the most part greater than those by the Australian Mutual Provident table, but are still on the whole less than the H^M values, particularly for the older ages at entry." (The H^M values were less for age at entry 20, durations 5 to 25, and at age at entry 30, durations 5 and 10.) He had calculated some $3\frac{1}{2}$ per-cent policy-values based on the present investigation, and a comparison with the H^M Table gave the following results: at age 20 at entry the H^M values were considerably less up to duration 40 inclusive (beyond which he had not carried the calculation), for age 30 at entry the H^M values were less for durations 5 to 30 inclusive, and for age 40 at entry the H^M values were less for durations 5 and 10. As the population increased in density, it was possible that the rate of mortality experienced in Australia might not compare so favourably as at present with that of this country, but time alone could settle that question. It must be borne in mind also that these colonies had been remarkably free from serious epidemics of fatal diseases, such as small-pox and cholera, and in this connection he noticed that at the present moment the authorities in Sydney were greatly concerned as to the imminent possibility of an outbreak of small-pox, the danger being the greater owing to the fact that less than 3 per-cent of the population had been vaccinated. It was to be hoped that Messrs. Moors and Day would see their way to make another investigation into the mortality experience of the colonies, utilizing the census which would be taken this year.

Mr. L. F. HOVIL said many would be to some slight extent disappointed at the authors having confined their attention to two colonies only. The mortality in the two colonies of New South Wales and Victoria had been treated separately in the past, the first by Professor Pell and the second by Mr. Burridge, and when Mr. Burridge in 1884 read his paper on the mortality of the combined colonies, Queensland, New South Wales, and Victoria, it was generally, he believed, thought that the extension of the area of the observations was a decided improvement. The reason the

authors gave for excluding Queensland was that they wished to do away with any effect that residence in the tropics might have on the figures. Mr. BurrIDGE, in 1884, found he was obliged to throw out the figures of South Australia, as the deaths for age 50 and onwards were grouped together. He did not know whether that difficulty was still in existence. A reason for including Queensland, and for making the basis as wide as possible, would surely be the use of the figures for industrial insurance. He supposed that the industrial offices doing business in New South Wales and Victoria extended their operations to Brisbane and Adelaide.

Mr. FITZSIMONS—They extend their business throughout the whole of the colonies.

Mr. HOVIL said, therefore, if they wanted to use it for industrial business, it would be better not to limit the investigation to the two colonies only. The figures of Table N were compared with Mr. BurrIDGE's figures of 1884, but as Queensland had been left out, it would have been better if the authors had compared their results with the Victoria Table which Mr. BurrIDGE had got out separately in 1884. The mean death rate for the Victorian mortality was about 15·8, as against 15·6 for New South Wales, so they were very similar, and this comparison he thought would be a fairer one than that which the authors had made. In paragraph 14 the authors laid down the very proper maxim that the years over which the observations extended should not be marked by any extremes in the way of mortality, and they then gave Table D. Turning to that table, apparently they had included one year, 1889, which showed an abnormally heavy rate of mortality, for the death rate given there for Victoria was quite 3 per thousand more than the average rate for the 10 years. They referred to the light mortality for one of the other years, but it was just as important not to include a year which had been marked by a specially heavy rate. Mr. Baker made some allusion to the decrease in the death rate being possible owing to the decrease of the excess of immigrants over migrants, but he (Mr. Hovil) thought it more likely to be partly accounted for by the very steady decline in the birth rate. In 1890 the birth rate for Victoria was 33·6, it had declined to 28·6 in 1895, and it went steadily down to as low a figure as 25·7 in 1898. Looking to the very heavy rate of mortality among infants, the saving in the general death rate caused by a light birth rate, was at once apparent. The female mortality figures the authors had found extremely light, and they were, therefore, rather dubious in asking the Institute to place reliance upon them. He thought that the light female mortality was equally striking in Mr. BurrIDGE's investigation, and the same feature was to be noticed, he had found, in the New Zealand female mortality in the tables got out by Dr. Leslie.

Mr. FITZSIMONS said he felt very gratified indeed at having the opportunity of being present at that meeting, and particularly so because of the fact that the paper under discussion was one dealing with the Australian Colonies, of which he was proud to be a native. It was very satisfactory to know that the Institute of Actuaries did not confine its attention to local matters only, but that it extended its interest and its attention thousands of miles away to a part of the

British Empire which, if he might use the words, was becoming more British than the English themselves. He was sure that the paper had entailed a very considerable amount of labour upon Messrs. Moors and Day, and only having had the paper recently put into his hands, he did not feel able to offer any remarks upon the absolute matter contained in it. However, he would take that opportunity of thanking the members for their invitation to be present that evening. He had come over as the representative of an Australian insurance company for the purpose of taking the initial steps to launch it in Great Britain; and he was quite sure that if they followed sound and safe lines they would in time earn the respect and esteem of the members of the Institute.

Mr. R. P. HARDY said the opening paragraph in the paper, in his judgment, was struck in the right note. It showed the mental standpoint of the authors, and disclosed, he thought, a breadth of view and a fulness of appreciation of the largeness of the issues involved that carried them far beyond the temporary personal interests of their narrow local limits, into the sphere of that doctrine which dealt with the numerical increase of the race under varied conditions.

The main point for them to consider that evening was whether the results of the paper could be accepted as showing the incidence of the death rates that had prevailed during the period of observation, and whether such might be relied upon for the purposes of life assurance as setting forth the rates of contribution and claim that would in future rule in the Australian colonies. In approaching that question they were met at the threshold, as the authors candidly avowed, with some serious weaknesses inherent in the data. That had necessitated the introduction of certain assumptions—assumptions, be it understood, made, as far as he could see, most judiciously, and probably no better could have been formulated by any expert over here; but, nevertheless, assumptions, of the appropriateness and the adequacy of which the members of the Institute could not judge. It would probably be urged that night that the method of graduation—so fully and so faithfully described—would cure these defects, but he ventured to entertain the doubt whether it was not beyond both the intention and the scope of any method of graduation with which they were acquainted to deal effectually with such deep-seated congenital imperfections. He was convinced that the authors had utilized their materials with the highest skill and to the utmost available extent, and that in the end they had given the Institute the best possible general representation of the past mortality, so far as the facts at command would permit, and that it was a considerable advance upon the bold pioneering essay of Mr. Burridge. But whether such might be both safely and properly adopted as the basis for estimating premium rates, or for the valuation of the outstanding risks of an assurance company, he took leave to consider that they had no sufficient evidence; and so he thought it would be more prudent to await a confirmatory investigation upon tested data.

Mr. H. W. MANLY said there was strong evidence that the authors had studied the subject very deeply, that they had made the best use of the material before them, and that the results were such

that they could, for the time being at any rate, safely use them until some more perfect data were available. The statistical abstracts of these colonies were certainly far superior to those that were produced here, the Registrars-General of the Colonies—being younger and more vigorous men, he supposed, and not tied up with the terrible amount of red-tape which strangled enterprise in this country — showed originality sometimes, and certainly always displayed a desire to give much more and better arranged information than could be obtained in the British returns. In many respects their returns would, he thought, be a very good model for the Registrar-General of England to base some reforms upon. He was not in a position to criticize the paper, beyond saying that so far as he had been able to judge, everything had been done with the materials that could possibly be done. He hoped that Registrars-General in the colonies might not be so self-important and obstinate as not to take notice of some of the requirements which actuaries might want in future investigations.

Mr. H. P. CALDERON said that there were one or two minor points on which it had occurred to him that a little fuller information might be useful. It was very unfortunate, but it certainly was not the fault of the authors, that the last year which they were obliged to include (in order to include an equal number of years on either side of the census) should be the year of the financial crisis in Australia. It would be noticed that in that year, whilst the migrations from New South Wales fell by a very large percentage indeed, those of Victoria, where the principal incidence of the crisis was felt, actually changed their sign. Both males and females were entered in the migration statistics, and whilst in the case of families, males and females might be of an equal average age, and, further, some females might migrate independently, yet the excess of male migrants seemed to indicate a large migration of bachelor males, say, under age 28, and that, therefore, the average age of females and of a section of the males, to the extent of the numbers of the females, might be as taken, yet the average age of the excess should be dealt with on different lines. He was very glad that only the colonies of New South Wales and Victoria were included, for some of the other colonies, being very large, would hardly form a basis for any estimate of the population, South Australia and Queensland possessing a special character. Certainly in New South Wales and in Victoria they might say that they had something which more fully approached what they would call healthy conditions. He therefore thought, in spite of what some might hold to the contrary, that the authors had done well in confining their attention to those two colonies.

Mr. C. H. E. REA said it was interesting to find it recorded by the authors of this paper that in Australia there existed the same distinct tendency to inflated records at the quinquennial ages 0—5 in the returns of the census as is common in other parts of the world. The irregularity was very noticeable in this country, and there appeared to be a prevailing idea in a large body of the general population, and especially among females, that they should remain 40 years of age until they arrived at 45, and when they eventually

accepted 45, they retained that age until after they arrived at 50, and so on. It therefore appeared to him that the suggestion made in the paper, as to using the quinquennial ages 0—5 as the centres for groupings might lead to some mistake in underestimating the real age.

Mr. J. E. FAULKS said it was a curious and a gratifying coincidence that Mr. BurrIDGE's first paper on Victorian mortality was read before the Institute on 27 March 1882—19 years ago almost to the very day. In the discussion on that paper Mr. T. JACQUES MARTIN, himself an Australian, asked Mr. BurrIDGE to effect for life assurance purposes a federation of the Australian figures, adding that political federation was the heart's desire of many of the Australian colonists. To-day that political federation was accomplished, and, as they all knew, the Heir Apparent to the Throne was on his way to open the first Federated Parliament of Australia. Mr. BurrIDGE federated his figures in 1884, so that they might congratulate themselves that their members were quicker in working than the politicians had been. With regard to the paper itself, there were several points to which one might refer. Table H, the table of migrants, was not stated to relate only to adults, but he presumed that it did. In paragraph 21 it would have been interesting if the authors had said whether they had made any investigation as to whether in the case of infants any gain by immigration was actually neutralized by emigration. As regards Victoria, he found, on referring to Mr. BurrIDGE's former paper, that he had used a very eloquent expression, namely, that Victoria exported infants. He did not know whether that was the same with New South Wales: possibly not, but a word on that point would have made the matter a little clearer. With regard to paragraph 24, they must all agree as to the danger of a table of expectation of life in unskilled hands; but he certainly thought that, for the purposes of the paper, it would have been an improvement if they had had that table for comparison with the values of Mr. BurrIDGE. The only Australian annuity table that he had been able to discover in the Institute *Journal*—he had not referred to the journals of the Colonial Institutes—was that in Professor PELL's paper, which was calculated at 4 per-cent, whereas this annuity table was calculated at $3\frac{1}{2}$ per-cent, and the annuity values also made continuous, so that a proper comparison was hardly possible. If they referred to tables N and O, which compared the values, one of p_x and the other of μ_x , with the values by certain other tables, they found a curious result with regard to the mortality over 60. Looking to Table N, they found that p_x , taking males as brought out by the new table, was greater, with the exception of the beginning of the table, than Mr. BurrIDGE's probability up to age 60, after which it was less. The same thing, with some slight modifications, held for females. Of course, they must not lay too much stress upon Mr. BurrIDGE's figures. These were, at the later ages, the healthy English tables modified, but it had occurred to him that the point he had referred to might conceivably be due to one of two causes. In the first place, it might be due to the process which had been followed in the distribution of the migrants. The migrants had been

distributed exclusively among the ages 15 to 64, and in proportion to the population at those ages, as he gathered. While granting that perhaps that was the only thing to be done with them, it seemed possible that that might have had some little effect in disturbing the mortality after the age of 64. Another curious point, still dealing with the question of mortality over 60, was that in the graduation which was done by Woolhouse's formula they found that the accumulated variation commenced to be lowered, or reached its largest limit—not that it was ever very large—at about the same age. Possibly further investigation might throw a little more light on the subject. There was one other curious feature in the resultant tables. If they looked at the annuity-values in the final table, they would find at the extremely old ages that in some cases the value of an annuity for the remainder of life was greater in the case of a male than in the case of a female. For instance, they found that at age 88 the female was greater than the male, that at age 89 the male was greater than the female, and that after a short space of time the female once more became greater than the male. That might possibly be a correct deduction from the figures, but it was contrary to most of the recognized English tables, although he believed that a similar thing was found in the American 'Thirty Offices' Table. If he might conclude with making a suggestion, he thought they would probably welcome a further contribution on the same subject from Messrs. Moors and Day, in which, instead of giving the monetary values of which they spoke at the end of the paper, they could follow out the line of thought indicated in paragraph 2, where they spoke of investigating the reasons why their rates differed to a sensible extent from those in the old country some 40 years ago, and from those of earlier dates in their southern land.

The PRESIDENT said that one trifle had not been mentioned, in that the authors spoke of excluding South Australia, so as to keep clear of any special mortality arising from residence within the tropics. He thought the authors had lost sight of the fact that most of them forgot their geography unless there happened to be a war, and that therefore it would be a good thing if the authors would put in two words to remind those in the old country that in the general reversal of things that took place on the other side of the globe, South Australia included a great deal of North Australia, and was thus brought under tropical influences. He was sure that they would wish to pass a hearty vote of thanks to the authors. He again expressed his sorrow that neither of them was there to acknowledge it.

REVIEW.

*Elements of Statistics.**

A GOOD English text-book on Statistics has been a long-felt want, and there can be little doubt but that Mr. Bowley has supplied this want in an admirable way.

Part I, the greater portion of the book, defines statistics and explains the method of investigation. For illustration the author takes the work of several of our leading Government departments. Having found how the raw material (or data) is procured, he discusses the best methods of tabulation. The next question as to how it can be summarized leads to the problem of averages and averaging, and also to graphical methods of showing the results.

Discussing a proposed definition of statistics as "the science of counting", Mr. Bowley is led to draw a clear distinction between arithmetic and statistics. "Whereas arithmetic attains exactness, statistics deal with estimates, sometimes very accurate, and often sufficiently so for their purpose, but never mathematically exact."

Mr. Bowley prefers, however, to regard statistics *à posteriori*. And throughout his work he proceeds to discuss the different methods found necessary in dealing with large numbers descriptive of groups. He refers to different sciences which rest on statistics, particularly biology, as shown by the writings of Karl Pearson.

When we come to the study of demography (which includes not only problems of population, increase, decrease, and distribution, but questions of income, wages, foreign trade, &c., &c.), we find ourselves dependent on the central or local administration for our statistics. Mr. Bowley mentions Booth's *Life and Labour of the People* and Leone Levi's *Wages and Earnings* as examples of what private enterprise has done in this direction. Equally interesting examples are the mortality statistics of Life Assurance Companies, and sickness statistics.

Hence Mr. Bowley is led first to describe the objects and working of the Census Department, of the Labour Department, and the Board of Trade foreign trade statistics, as the most important and best examples of Government statistics.

Mr. Bowley, however, makes many valuable suggestions as to additional information and organization that might be supplied by the administration of the country, *e.g.*, a quinquennial census, and a

* *Elements of Statistics.* By Arthur L. Bowley, M.A., F.S.S. London P. S. King & Son, 2 & 4, Great Smith Street, Westminster.

permanent staff; tabulation of market prices of staple commodities; returns of railway traffic similar to that by water, and a record of factory production.

The writer examines the census schedule minutely. As he points out, its most important defect is the break-down of the census of occupations; the data are radically defective and the tabulation does not enable us to say, for instance, how many persons are dependent on each particular industry.

It may not be generally known that in 1886 a Wage Census was undertaken by the Board of Trade. The data were supplied by employers voluntarily, and examples of the forms used are given. A valuable section is one describing the functions and methods of working of the Labour Department of the Board of Trade, established in 1893. This Department is an excellent example of what can be done by a Government Department, assisted by private enterprise, as the Department relies mainly on voluntary co-operation. While one of its most important functions is to record the state of employment month by month, we have to look to it for records of changes in wages. Thus an estimate as to the present national weekly wages bill in the United Kingdom rests on the Wage Census, corrected by the changes in wage earnings recorded since that date.

In discussing the tabulation of data, Mr. Bowley considers (1) groups giving statements of totals of persons or things which satisfy given conditions. This may involve single, double, triple, or even quadruple tabulation. As an example of the last, he gives a table by Mr. Booth, applying the census returns to London printers, showing occupation, industrial status, sex, and age. (2) "the grouping of a large number of units in relation to some particular property possessed by all." Here we are thrown on our own resources, so to speak, and the object of the tabulation is to reveal the true meaning of the figures. Mr. Bowley again gives interesting illustrations, and introduces the ideas of the "median" and the "mode", with which readers of the *Journal* have already met in Karl Pearson's work.

As one of the main objects of statistics is to deduce averages or causal relations, the graphical method is as important as the arithmetical or the algebraical. Those who prefer the graphical treatment will find plenty of material in the lengthy chapter on the Graphic Method. The graphical illustrations are very numerous. In fact, some are, perhaps unavoidably, overcrowded, and the different curves are somewhat difficult to disentangle. This might be remedied by the freer use of distinctive inks or types, or in other ways the curves might be more clearly disassociated. While the explanations will generally be found sufficient, still they sometimes err on the side of brevity, e.g., on p. 169 the three diagrams are pretty obvious to the eye, but the scales given at the side are by no means intelligible at first.

By way of illustration, Mr. Bowley discusses in this chapter several typical economic problems. As to the value of our export trade, he shows that decennial averages must be taken to eliminate

trade cycles, and his smoothened curve agrees with the decennial averages. The relative growth under the different heads of the total revenue; of the changes between the quantity and value of wheat imports and the consumption per head; of cotton imports and cotton exports, are well brought out by diagrams. He shows also the best method of comparing the progress in the trade of different countries; for example, instead of saying British or German trade has increased so much in a certain period, we get a better test by making the trade in 1900 the standard of comparison. And graphical methods of detecting correlation are also explained. All these methods are open to the objection that the increase or decrease in the ordinate represents absolute, not relative, increase. But for many purposes it is much more important to know the relative increase. If, however, we plot out the logarithms of the values of the function, we get another curve, in which equal vertical distances represent equal rates of increase. The method has many advantages, and deserves attention.

The theory of index-numbers does not possess much interest for the insurance profession generally, but the short chapter on the subject will prove of convenience to those who have occasion to examine it.

We must not omit to notice in the chapter on Interpolation a brief exposition of Makeham's hypothesis, as an example of one of those empirical formulæ which satisfy the observations with much exactitude. Such formulæ are numerous, but Makeham's is probably the best and most useful example.

In Part II, Mr. Bowley deals briefly, but thoroughly, with the application of probabilities leading up to the elementary application of the curve of error to statistical problems. This part is, perhaps, not of the same importance in the investigations with which actuaries are concerned, and we will therefore deal with it very shortly.

In sect. 5, several important applications of the curve of error are succinctly established. Of the important theorem that "the modulus of an unweighted average of n quantities, conforming to a curve with modulus c , is $\frac{c}{\sqrt{n}}$ ", several demonstrations are given.

The same proposition is more generally put "the precision of an average is proportional to the square root of the number of terms it contains."

By means of this proposition he shows that the formula $\sqrt{\frac{2\Sigma d^2}{n-1}}$ is more correct than $\sqrt{\frac{2\Sigma d^2}{n}}$ for the modulus.

The most important application is to the principle of "Samples" or "random selections." In many cases we can only get samples of observations, and Mr. Bowley shows (p. 308) that even if the original observations do not follow the normal curve of error, the averages deduced from groups of samples very often may.

In the concluding section, Mr. Bowley gives the elements of the numerical measurement of correlation.

The method is made very clear by the interesting example of supposed correlation between Marriage Rate and Price of Wheat. The graphical method is often just as convenient for investigating correlation. Readers of the *Journal* who have read Prof. Pearson's papers that have appeared there, will be glad to see a description (p. 322) of Mr. Galton's method of estimating correlation, especially for its application to the biological theory of "regression."

While little but praise can be paid to this excellent work, it is unfortunate that some typographical errors appear, none, however, of any serious importance.

On p. 170, "60 and 67" should be "40 and 67"; p. 258, $A + Bc^x dx$ should be $(A + Bc^x)dx$, and "Woodhouse, in the *Assurance Magazine*", is a reference to Woolhouse; p. 282, $u = .47694$ should be $x = .47694$; p. 284, line 8, x'' should be x_r ; on p. 293, line 9 from bottom $\frac{2pq}{n^2}$ should be $\frac{2pq}{n^2}$; p. 304, last line $\bar{x} = \sum a \frac{(x' \div \epsilon)}{xa}$ should be $\bar{x} = \frac{\sum a(x' + \epsilon)}{\sum a}$; p. 312, line 7 from foot, 43.2 should read 43.2 months. And on p. 286, line 11 from foot, the ratio of the precision seems to be 2 instead of 10.

We must not omit reference to a very useful index to the work, and on p. 327, those interested in the theoretical side of statistics will find a good practical English bibliography of the subject.

J. H.

THE LIFE ASSURANCE COMPANIES OF THE UNITED KINGDOM.

Summary of the Life Assurance and Annuity Revenue Accounts.

[Extracted from the Parliamentary Return for 1900, published in 1901.]

I N C O M E	Ordinary Companies	Industrial Companies	TOTAL
	£	£	£
Balance at the beginning of the Year	231,339,585	18,392,283	249,731,868
Premiums	21,259,186	8,422,577	29,681,763
Consideration for Annuities	2,139,014	7,633	2,146,647
Interest and Dividends (less Tax)	8,755,116	615,503	9,370,619
Increase in value of Investments	363,099	433	363,532
Fines, Fees, &c.	13,184	692	13,876
Capital Paid-up	30,578	119,305	149,883
Customs Timber Measuring, &c.	3,240	...	3,240
Transfers from other Accounts	16,114	57,854	73,968
Miscellaneous	9,428	210	9,638
	263,928,544	27,616,490	291,545,034

O U T G O	Ordinary Companies	Industrial Companies	TOTAL
	£	£	£
Claims	15,881,168	3,410,642	19,290,810
Cash Bonuses and Reduction of Premiums	893,426	2,019	895,445
Surrenders	1,005,723	35,372	1,041,095
Annuities	1,714,573	7,368	1,721,941
Commission	1,159,215	2,118,999	3,278,214
Expenses of Management	1,778,891	1,479,208	3,259,099
Bad Debts	11,808	455	12,263
Decrease in value of Investments	155,516	7,599	163,115
Interest on Capital and Dividends and Bonuses to Shareholders	564,733	470,593	1,035,326
Transfers to other Accounts	63,013	50,073	113,086
Miscellaneous	11,493	...	11,493
Balance* at the end of the Year	240,688,985	20,034,162	260,723,147
	263,928,544	27,616,490	291,545,034

* This Balance includes the whole of the Life and Annuity Funds (£256,966,879), and, in addition, the Capital of Companies whose business is limited to Life Assurance only.

Summary of the Balance Sheets (1901).

LIABILITIES	Ordinary Companies	Industrial Companies	TOTAL
	£	£	£
Paid-up Capital (including sundry Shareholders' Balances) . . .	11,438,138	1,632,624	13,070,762
Life and Annuity Funds . . .	238,196,831	18,770,048	256,966,879
Fire Funds of Companies trans-acting Life Business . . .	10,768,450	...	10,768,450
Marine Funds of Companies trans-acting Life Business . . .	608,999	...	608,999
Reserve Funds . . .	4,469,389	800,000	5,269,389
Other Funds . . .	1,487,092	208,553	1,695,645
Profit and Loss Balances . . .	4,534,576	...	4,534,576
Depreciation and Investment Balances . . .	1,037,242	18,549	1,055,791
Globe Annuity (Liverpool and London) . . .	1,102,800	...	1,102,800
Outstanding Claims . . .	4,170,824	60,152	4,230,976
Outstanding Accounts . . .	729,093	17,458	746,461
Temporary Loans . . .	348,040	5,000	353,040
	278,891,384	21,512,384	300,403,768
ASSETS	Ordinary Companies	Industrial Companies	TOTAL
	£	£	£
Mortgages . . .	80,378,698	2,297,414	82,676,112
Loans on Policies . . .	12,424,969	38,136	12,463,105
„ Rates . . .	24,070,856	7,351,793	31,422,649
British Government Securities . .	4,867,974	1,862,870	6,730,844
Indian and Colonial Government Securities . . .	18,425,174	381,129	18,806,303
Foreign Government Securities . .	10,155,387	406,533	10,561,920
Debentures . . .	49,128,470	2,036,920	51,165,390
Shares and Stocks . . .	34,473,281	98,166	34,571,447
Companies' own Shares . . .	632,230	...	632,230
Land and House Property and Ground Rents . . .	21,433,029	5,634,532	27,067,561
Life Interests and Reversions . .	7,238,681	2,010	7,240,691
Loans on Personal Security . .	1,406,439	6,938	1,413,377
Agents' Balances and Outstanding Premiums . . .	5,641,855	528,902	6,170,757
Outstanding Interest . . .	2,579,676	187,985	2,767,661
Cash, Deposits, Stamps, &c. . .	5,806,186	226,874	6,033,060
Customs Timber Measuring Balances, &c. . .	2,119	...	2,119
Deficiencies, Preliminary Expenses, &c. . .	226,360	452,182	678,542
	278,891,384	21,512,384	300,403,768

INCREASE (+) or DECREASE (—) in the Chief Items of this Year's
SUMMARY as compared with the corresponding Items for the
previous Year.

	Ordinary Companies	Industrial Companies
INCOME.		
	£	£
Premiums	+ 430,169	+ 343,849
Consideration for Annuities	— 217,798	— 3,901
Interest and Dividends (less Tax)	+ 364,264	+ 51,973
Net Result of Realization and Re-valuation of Investments	+ 136,710	— 7,235
OUTGO.		
Claims	+ 283,819	+ 278,726
Annuities	+ 111,504	+ 671
Surrenders	+ 13,041	— 9,625
Commission	— 7,896	+ 27,519
Expenses of Management	+ 27,288	— 26,742
LIABILITIES.		
Paid-up Capital (including sundry Share- holders' Balances)	+ 7,357	+ 118,626
Life and Annuity Funds	+ 9,322,670	+ 1,545,421
ASSETS.		
Mortgages (including Loans on Rates)	+ 233,185	+ 1,010,056
Life Interests and Reversions	+ 717,641	+ 3
Loans on Policies	+ 543,278	+ 107
British Government Securities	+ 40,258	+ 39,106
Indian and Colonial Government Securities	+ 279,482	+ 24,568
Foreign Government Securities	+ 1,541,995	+ 8,759
Debentures	+ 3,261,733	+ 130,894
Shares and Stocks	+ 2,329,936	+ 19,493
Companies' own Shares	— 6,518	...
Land and House Property and Ground Rents	+ 1,103,365	+ 474,821
Loans on Personal Security	— 175,626	— 421

NUMBER OF COMPANIES.

The total number of Companies appearing in the above Summary is 95, of which 81 have been classed as Ordinary, 10 as Industrial, and 4 appear in both Classes, the Returns of these Companies showing the Ordinary and Industrial business separately.

SUMMARY OF THE ASSURANCES IN FORCE, *as shown by the last Returns of the Companies.*
ORDINARY BUSINESS.

	WITH PROFITS		WITHOUT PROFITS		TOTAL		Re-assur- ances	Net
	No.	Amount	No.	Amount	No.	Amount	Amount	Amount
ASSURANCES.		£		£		£	£	£
Whole Term of Life	783,126	376,616,030	139,063	67,929,938	922,489	444,545,968	25,424,655	419,121,313
Limited number of								
Premiums . . .	43,614	26,797,404	8,707	3,802,180	52,321	30,599,584	1,556,014	29,043,570
Endowments . . .	827,940	403,113,434	147,770	71,732,118	974,810	475,145,552	26,980,669	448,164,883
Endowment Assur- ances . . .	1,983	435,898	15,313	4,007,955	17,296	4,443,853	10,500	4,433,353
Joint Lives . . .	774,264	129,515,961	46,726	14,627,270	820,990	144,143,231	2,160,777	141,982,454
Last Survivor . . .	16,272	3,360,885	2,678	1,091,964	18,950	4,452,849	401,206	4,051,643
Contingent . . .	902	723,519	1,113	1,462,826	2,015	2,186,345	419,279	1,767,066
Issue . . .	30	55,759	3,895	5,678,840	3,925	5,734,599	1,316,161	4,418,438
Miscellaneous . . .	4	13,500	1,267	4,740,123	1,271	4,753,623	1,337,830	3,415,793
	2,281	1,249,950	7,160	9,105,973	9,441	10,355,923	1,677,770	8,678,153
	1,622,776	538,768,906	225,922	112,447,069	1,848,698	651,215,975	34,304,192	616,911,783
ANNUITIES.								
Immediate . . .	...	...	...	...	30,062	1,571,811	41,712	1,530,102
Deferred . . .	...	...	...	...	11,381	306,435	16,473	289,962
	...	...	...	...	41,443	1,878,249	58,185	1,820,064

INDUSTRIAL BUSINESS (Sickness and Friendly Society Contracts not included).

	WITH PROFITS		WITHOUT PROFITS		TOTAL		Re-assur- ances	Net
	No.	Amount	No.	Amount	No.	Amount	Amount	Amount
ASSURANCES.						£	£	£
Whole Term of Life	17,001,830	164,397,976	1,000	164,396,976
Limited number of								
Premiums	1,416	13,334	500	12,834
Endowments	17,003,246	164,411,310	1,500	164,409,810
Endowment Assur- ances	1,097,460	9,017,360	...	9,017,360
Joint Lives	200,389	2,205,554	88	2,205,466
Contingent	343,746	5,501,092	...	5,501,092
Miscellaneous	4	1,910	400	1,510
	1	300	...	300
	18,653,846	181,137,526	1,988	181,135,538

THE INSTITUTE OF ACTUARIES.

RULES AND SYLLABUS OF EXAMINATIONS.

IN *J.I.A.*, xxxiv, 413, are given the Rules and Syllabus of Examinations, then revised. The following is a reprint, which, as regards the Rules, contains a few alterations, scarcely more than verbal. The Syllabus remains unchanged.—Ed. *J.I.A.*

RULES prescribed by the Council of the Institute to regulate Examinations qualifying for admission to the Classes of Student, Associate, and Fellow. respectively.

GENERAL REGULATIONS.

1. The Examinations shall, until further notice, be conducted in writing, under such conditions as the Council may prescribe.
2. The Examiners shall place successful Candidates in three Classes, according to merit, and the names in each Class shall be arranged in alphabetical order.
3. No Candidate will be allowed to present himself for Examination until he has paid all Entrance Fees, Subscriptions, and Examination Fees that may be due.
4. Examinations will be held in April of each year, or at such other time as the Council may prescribe.

Examinations in the United Kingdom.

5. At least one month's public notice will be given of the days and hours, and of the place or places, of the Examinations.
6. Candidates for any Examination must give to the Honorary Secretaries fourteen days' notice in writing of their intention to present themselves for Examination, and must specify the particular Examination.

Examinations in the Colonies.

7. Public notice will be given, not later than in November of each year, by advertisement in at least one newspaper of the Colony in which an Examination is to be held, of the date and place of such Examination.
8. Candidates for any Examination in a Colony must give to the Honorary Secretaries notice in writing of their intention to present themselves for Examination, and must specify the particular Examination. Such notice must be posted in time to reach the Honorary Secretaries in London not later than on the 31st January preceding the date of the Examination.

CLASS OF STUDENT.

1. Candidates for admission to the Class of Student must, at the time of giving notice of their intention to present themselves for Examination, pay an Entrance Fee and an Examination Fee, each of £1. 1s.

2. Candidates who have paid the above Fees, and whose applications for admission have been approved by the Council, shall, unless exempted under the next clause, be examined in the subjects set forth in Part I of the annexed Syllabus. Application must be made on the form prescribed by the Council which may be obtained from the Honorary Secretaries.

3. Graduates in Mathematical Honours of any University in the United Kingdom will be exempt from Examination in Part I of the Syllabus.

4. In the event of a Candidate passing the Examination, he will be admitted a Student after he has signed the Form of Obligation prescribed by the Council, and paid his Subscription of £1. 1s. for the current year.

5. In the event of a Candidate failing to pass the Examination, he shall, subject to the approval of the Council, and on payment of the Examination Fee, be permitted to be examined in a subsequent year.

CLASS OF ASSOCIATE.

1. Students shall be required to pass Parts I and II of the Syllabus to qualify for admission to the Class of Associate, and, subject to the exceptions contained in these Rules, no Student shall present himself for Examination in the second part unless he shall have previously passed the first part of the said Examination.

2. Candidates for Examination in either Part must, at the time of giving notice of their intention to present themselves, pay a fee of £1. 1s.

3. Students of the Institute admitted after 1st October 1898, shall be required to pass only Part II of the Syllabus to qualify for admission to the Class of Associate.

4. Fellows (by Examination) of the Faculty of Actuaries in Scotland will be considered by the Council, other circumstances being in their view favourable, to be eligible as Associates, without passing the Examinations for admission to the Class of Associate.

CLASS OF FELLOW.

1. Students or Associates shall be required to pass Parts I, II, III and IV of the Syllabus to qualify for admission to the Class of Fellow, subject to the exceptions contained in these Rules. No Candidate shall present himself for Parts III and IV until the expiration of at least twelve months after passing Part II.

2. Candidates may present themselves for Parts III and IV in the same year, and in the event of a Candidate passing in Part IV and failing in Part III, he may present himself for Part III alone in a subsequent year. Otherwise Part III must be passed before Part IV.

3. Candidates for Examination in Parts III and IV must, at the time of giving notice of their intention to present themselves, pay a fee of £1. 1s. in respect of each part for which they enter.

4. Associates who, prior to the commencement of the Bye-Laws (26th February 1886), had passed Part I or Parts I and II, shall be required to pass only Parts II, III and IV, or only Parts III

and IV, respectively, of the Examination to qualify for admission to the Class of Fellow.

5. Associates admitted after 26th February 1886, shall be required to pass only Parts III and IV of the Examination to qualify for admission to the Class of Fellow; and Students admitted after 1st October 1898 shall be required to pass only Parts II, III and IV of the Examination to qualify for admission to the Class of Fellow.

N.B.—Part III, Section A of the Syllabus dated 9th January 1894 shall be held to be equivalent to Part IV; and Part III, Section B, to Part III of this Syllabus.

By order of the Council, 14th May 1901.

ERNEST WOODS,
FREDERICK SCHOOLING, } *Hon. Secs.*

[Attention is called to the Regulations for Probationers printed on page 208.]

SYLLABUS OF EXAMINATIONS

Referred to in the annexed Rules.

PART I.

- (1) Arithmetic and Algebra.
- (2) The Theory and use of Logarithms.
- (3) The Elements of the Theory of Probabilities.
- (4) The Elements of the Calculus of Finite Differences, including Interpolation and Summation.

PART II.

- (1) Compound Interest and Annuities-Certain.
- (2) The application of the Theory of Probabilities to Life Contingencies.
- (3) The Theory of Annuities and Assurances on Lives and Survivorships.
- (4) The principles of the construction of Mortality Tables (excluding graduation): and the construction of monetary and other Tables involving the Contingencies of Life.
- (5) The elementary application of the Calculus of Finite Differences and of the Differential and Integral Calculus to Life Contingencies.

PART III.

- (1) The methods of constructing and graduating Mortality, Sickness and other Tables.
- (2) The history and distinctive features of existing Tables.
- (3) The Valuation of the Liabilities and Assets of Life Assurance Companies.
- (4) The Distribution of Surplus.
- (5) The Calculation of Office Rates for Assurance, Annuity, Sickness and other risks.
- (6) The practical valuation of Life Interests and Reversions, and of Policies for surrender or purchase.

PART IV.

- (1) The Elements of the Law of Real and Personal Property.
- (2) The Law relating to Life Assurance Companies and Life Assurance Contracts.
- (3) The Constitution and Valuation of Friendly Societies and Pension Funds, and the Laws relating to such Institutions.
- (4) Life Assurance Book-keeping; preparation of Schedules, Statements and Reports.
- (5) The Principles of Banking and Finance, including a knowledge of the Constitution and Operations of the Bank of England, and of the National and Local Debts of the United Kingdom.
- (6) The Investments of Life Assurance Companies.

REGULATIONS FOR PROBATIONERS.

The Council has established a Class of Probationers who, while not being Members of the Institute, shall be allowed some of the privileges of the Members.

Persons desiring to become Probationers shall apply to the Council, and, if their applications are approved, shall become Probationers on payment of an entrance fee of 10s. 6d., but the Council may at any time withdraw their approval, and thereupon the person shall cease to be a Probationer. Should the Probationer subsequently be admitted a member of the Institute, this fee of 10s. 6d. will be taken as paid on account of the entrance fee as Student.

The annual subscription for Probationers is 10s. 6d., payable on admission and on 1st October in each year. If the subscription for any year be not paid before the 31st December, then the defaulter shall no longer be a Probationer.

Probationers will be entitled to join the classes for Students, in accordance with the rules prescribed for such classes, and to attend the Ordinary General Meetings of the Institute, but not to vote or take part in the discussions thereat.

Probationers may borrow books from the Library for the purposes of their studies, but this privilege is subject to the discretion of the Librarians and to the rules which the Council may from time to time prescribe.

ERRATA IN THE *JOURNAL*.

In the preparation of the Card Index of the *Journal*, the following misprints in Vol. xxxiv have been discovered:—

		Error	Correction
Page 492	Line 19	Vol. ii, p. 142	Vol. vii, p. 243
" 542	{ 2nd Table, Col. 4. } Line 5	36·8	26·8
" 552	{ 1st foot-note 2nd ..	Vol. xxv, p. 250 .. xxvii, p. 544	Vol. xxv, p. 350 .. xxix, p. 544

6

JOURNAL

OF THE

INSTITUTE OF ACTUARIES.

On the Valuation of Staff Pension Funds. By HENRY WILLIAM MANLY, *Actuary of The Equitable Life Assurance Society, and Ex-President of the Institute of Actuaries. With Tables and Examples by ERNEST CHARLES THOMAS, of The Gresham Life Assurance Society, and Fellow of the Institute of Actuaries.*

[Read before the Institute, 29 April 1901.]

IN a short paper, which I read before the Second International Actuarial Congress, held in these rooms in May 1898, I gave the solution of some problems which frequently arise out of the Rules of Pension Funds and Friendly Societies. That paper is printed in the *Transactions* of the Congress, published by the Institute, page 860. I was unfortunate in the selection of the table which I used for illustrating the formulas, as there was a printer's error in the value of the most important term. That, however, did not affect the formulas themselves. Mr. McGowan, in a letter to the *Insurance Record* of 2 February 1900, said that my remark on page 861 (of the *Transactions*), that "it will be P years before the annuity payments equal the price given, does not seem quite correct in the case where P is an integer plus a fraction", and I explained, in a letter which appeared the following week, that the correction, which would be the value of the assurance of the fraction of the annuity for the

fraction of the year in which the fraction would occur, is so insignificant that it might be ignored.

There are so many disturbing elements in the valuation of these Funds that the omission of such a super-refinement will not affect the value of the formulas for all practical purposes. I am afraid that all those gentlemen who are ultra-exact will find many things to object to in this paper; but those who have had anything to do with the valuation of Pension Funds know perfectly well how unstable the data are on which the calculations are based, and how frequently the Rules are changed; and that if the calculations were made with the minutest accuracy, the result could only be considered a close approximation. Instead of attempting extreme refinement in our tables and formulas, it will be found that the better plan is to use the simplest and most easily constructed tools, and to make adjustments after the rough part of the work has been performed.

The valuations of Widows' and Ministers' Pension Funds, membership of which is voluntary or semi-voluntary, have been fully explained by Messrs. D. Deuchar, Hewat, Huie, Meikle, Sprague, and others; but I am not aware that any explanation has been given of the valuation of those Funds which are intended to provide superannuation for the members of the staff of a public institution or a great commercial undertaking, where membership is compulsory. Many interesting problems occur in connection with the valuation of these Funds, and it seemed to me that a paper dealing with these in a practical manner would not be unwelcome to the Members of the Institute. To carry out such a scheme alone would have involved an amount of time and labour which I could not afford. Mr. Thomas, however, willingly offered to co-operate in the work, and to make all the necessary calculations; and we now present to you the result of our joint labours. The published work does not represent the whole of our labours by a great deal, as you will very well understand, because in carrying out investigations in a practically new field of research, much has to be eventually discarded.

The first object to which we devoted our attention was the procuring of data which was to form the basis for use in our work. It appeared to us that the best working basis would undoubtedly be a table representing the aggregate experience of a number of large Pension Funds, and we accordingly approached some of the larger railway companies with a request

to supply us with their experience. We were courteously referred to the actuaries who valued the Funds, and through their kindness we became possessed of a large amount of information, but, unfortunately, not much of it in a form useful for our purpose. In very few cases were the actual data given, the experience being generally recorded in tabular form as percentages for quinary groups of ages; and the age groupings were not always the same. Altogether, we found it impossible to make a Table of aggregate experience from actual data, and had to content ourselves with constructing a hypothetical table which would fairly represent the general features of an average of the several experiences. Under these circumstances, we did not consider it necessary to use large figures; hence the somewhat meagre appearance of some of the Tables.

In the construction of Experience Tables for use in this kind of work, it is desirable, in order to avoid complicating the formulas, to follow such lines as will, in their subsequent application, prove the lines of least resistance.

We first built up from the several Reports, as well as we could, average rates of mortality, withdrawal, superannuation, and annual salary for each age, and graduated these by means of a very simple and useful instrument called a spline, which is a tapering square-edged flexible ruler made of lance wood. The Table, which we will call the Hypothetical Pension Fund Experience Table, was constructed from this material in the ordinary way, but in the use of this Table we have assumed that the age is the exact age; that the withdrawals and deaths occur at the end of the year; that retirements or superannuation take place at the end of the year; and that the salary opposite the age is the salary received for one complete year, each increase taking place on a birthday. In fact, it is supposed to represent a table constructed strictly on the nearest age and nearest duration method. By these means, the construction of monetary Tables is greatly simplified, and adjustments can always be applied afterwards to accommodate the Tables to any set of circumstances or conditions.

Throughout the whole of this paper the pension age is exactly 65; and it is assumed that after age 65 the mortality rate is the same as the English Life Table No. 3.

With the object of showing the effect of allowing for withdrawals and early superannuation, we decided to construct from our experience rates three Tables which should exactly correspond;

the first, containing no withdrawals or retirements, representing, in fact, an ordinary mortality Table; the second, allowing for withdrawals but not retirements; and the third, allowing for both withdrawals and retirements. These Tables will be found on pages 261-2. They were really constructed in the reverse order, but we thought that, for the purpose of comparison, it would be better to start with the more familiar form. It was found necessary, not only for the purpose of building up the first and second Tables, but for ascertaining subsequently the provision to be made for early superannuations or invalid retirements, that a rate of mortality likely to prevail amongst the class of early superannuated should be determined. For this we had no reliable data to go upon, and our only guide was certain rough estimates which had been made, to the effect that the rate of mortality prevailing amongst those who were compelled to retire early was somewhere about 10 per-cent. That the rate is likely to be high, amongst those who are compelled to retire at an early age, necessarily follows from the fact that they are men utterly broken down in the service, who are generally suffering from brain trouble or some chronic incurable disease. As the pension age is approached, there is a tendency to force the incompetent men to retire, and the average rate of mortality will therefore, in all probability, gradually approach the normal as the ages increase, arriving at the normal at age 65. Following out these ideas, we made a bold assumption that the rate at the earliest age (29) would be 10 per-cent, and that this would decrease by .1 per-cent for the next 2 years, and then by .15 per-cent each year down to 4.7 per-cent at age 65, which is practically the rate at that age according to the English Life Table No. 3.

The next thing to be done was to construct the usual commutation columns for each of the three Tables; but for these we had to fix the rate of interest. We decided to adopt 4 per-cent throughout, as that is the rate either allowed or guaranteed by most of the large railway companies.

To distinguish the columns with reference to the Tables on which they are constructed, we shall place the number of the Table in a bracket as an index to the columnar symbol; thus, $D_x^{(2)}$ is the D_x for Table 2, $N_x^{(3)}$ is the N_x for Table 3 and so on. The columns were formed in the usual way, N_x and M_x being grafted on to the English Life Table by making $N_{65} = D_{65} \times a_{65}^{\text{English Life}}$, and $M_{65} = C_{65} \times \frac{M_{65}}{C_{65}} \text{ English Life}$.

The different results produced by the use of the three different kinds of mortality Tables are shown in the following Table A, which gives the values of certain benefits, the formulas for which will be found in the paper in the *Transactions* of the Second Actuarial Congress already referred to. The Problems selected for illustration are :

Problem I.—What is the price of an immediate annuity of 1 on the life of (x) , with the condition that if the life should die, before the payments amount to the price given, the balance between the price given and the total annuity payments shall be returned ?

Problem IV.—What is the annual premium payable for n years for an annuity of 1 on the life of (x) to commence at the age of $(x+n)$ with the condition that no money shall be returnable in the event of death before age $(x+n)$, but if death occurs after the annuity is entered upon, and before the annuity payments amount to the total premiums paid, the balance shall be returned ?

Problem V.—What is the annual premium payable for n years for an annuity of 1 on the life of (x) , to commence at the age of $(x+n)$, with the condition that if death occurs before the annuity commences, all the premiums paid shall be returned, and if death occurs after the annuity commences, but before the annuity payments amount to the total premiums paid, the balance shall be returned.

The premiums for the annuities without any return have been inserted in the Table, in order that the effect of the conditions can be seen by comparison.

TABLE A.—Comparison of Values by the three different forms of Tables.

Age x	THE VALUES OF SIMPLE ANNUITIES OF 1			ANNUITY OF 1, WITH RETURN Problem I Table 2 (5)	ANNUAL PREMIUM FOR PENSION OF 1 AT 65, WITHOUT ANY RETURN N_{65} $= N_{x-1} - N_{64}$				ANNUAL PREMIUM FOR PENSION OF 1 AT 65, WITH RETURN ON DEATH AFTER 65 ONLY. PROBLEM IV.				ANNUAL PREMIUM FOR PENSION OF 1 AT 65, WITH RETURN ON DEATH BEFORE AND AFTER 65. PROBLEM V.		
	a_x Table 2 (2)	a_x Table 3 (3)	a_x Table 4 (4)		Table 2 (6)	Table 3 (7)	Table 4 (8)	Table 2 (9)	Table 3 (10)	Table 4 (11)	Table 2 (12)	Table 3 (13)	Table 4 (14)		
(1)															
15	19.82	9.50	9.43	...	.027	.016	.009	.027	.016	.009	.034	.018	.010
20	19.12	11.60	11.31	...	.035	.025	.015	.036	.025	.015	.045	.030	.017
25	18.31	13.32	12.84	...	.046	.037	.023	.047	.038	.023	.050	.047	.027
30	17.35	14.14	13.43	18.26	.061	.054	.033	.063	.055	.033	.082	.070	.040		
35	16.26	14.25	13.31	17.32	.083	.078	.048	.086	.080	.048	.113	.101	.060		
40	15.02	13.96	12.71	16.26	.118	.114	.071	.122	.118	.072	.162	.154	.089		
45	13.65	13.21	11.65	15.13	.173	.171	.109	.182	.180	.111	.241	.238	.138		
50	12.20	12.12	10.22	13.93	.274	.274	.179	.293	.292	.185	.384	.384	.226		
55	10.67	10.64	8.48	12.67	.494	.493	.342	.543	.543	.358	.688	.688	.425		
60	9.15	9.14	6.95	11.40	1.200	1.200	.914	1.389	1.389	.993	1.644	1.645	1.125		

These figures will suffice to show the enormous effect on the values of benefits when secessions are allowed for, and the great importance of not over-estimating the withdrawals.

The values by Problem I are calculated for one table only, because there are no secessions after an annuity is entered upon, and the values must therefore be the same by all the Tables.

If it be desired to calculate the premium for a pension according to Problem IV, commencing at an earlier age than 65, by Table 3, the formula will have to be altered. The formula given in the *Transactions* for an ordinary mortality Table is

$$(N_{x-1} - N_{x+n-1})P = N_{x+n} + nPM_{x+n} + R_{x+n+nP+1} - R_{x+n+1}.$$

Now all secessions must cease at age $x+n$, consequently all the terms on the right-hand side of the equation, must be based on Table 2 (where no secessions occur), and then discounted by Table 3, thus—

$$\frac{(N_{x-1}^{(3)} - N_{x+n-1}^{(3)})P}{D_x^{(3)}} = \frac{N_{x+n}^{(2)} + nPM_{x+n}^{(2)} + R_{x+n+nP+1}^{(2)} - R_{x+n+1}^{(2)}}{D_{x+n}^{(2)}} \cdot \frac{D_{x+n}^{(3)}}{D_x^{(3)}}$$

whence

$$P = \frac{N_{x+n}^{(2)} + R_{x+n+nP+1}^{(2)} - R_{x+n+1}^{(2)}}{\frac{D_{x+n}^{(2)}}{D_{x+n}^{(3)}} (N_{x-1}^{(3)} - N_{x+n-1}^{(3)}) - nM_{x+n}^{(2)}}$$

a formula which looks formidable, but in reality is simple to calculate.

Funds intended to provide a retiring allowance for the members of a staff, are started by employers with the very best intentions, but it is doubtful whether they have ever proved altogether satisfactory. They have the tendency to breed a discontented spirit amongst the employees, and in some cases have proved more costly to the employers than if they had created their own Reserves and promised to give a guaranteed scale of superannuation for long and faithful service.

The general principle is undoubtedly good, and morally sound in the abstract, but it takes no account of the weakness of human nature. The principle that everyone should make a provision for his old age is one which we shall all approve. To encourage this principle, the employer says to his employees: "If you will all consent to contribute a percentage of your salaries to create a Fund for providing pensions in your old age, I will subscribe an equal amount each year"; or, "I will give you a sum down to start the Fund." Sometimes he adds:

“and I will guarantee that the Fund shall be accumulated at a fixed rate of interest.” In this way he feels that he has acted the part of a philanthropist in encouraging thrift; he thinks that his staff will be more contented and settled, and are not likely to leave him when they have a stake in the Fund; and he has allayed an uneasy conscience which half recognized an unpleasant responsibility to help, in his old age, a man who has given him a lifelong service. The employee’s view of the arrangement is very different. To him the contribution is a hardship and an obnoxious tax; and, although he gave his consent to subscribe, it was an agreement made under moral compulsion. What benefit will it be to him? He will never live to 65! and if he does, he is not going to stick in that firm all his life. He does not see why he should be taxed for the benefit of the old members of the staff, who will be retiring soon. The governors might at least raise their salaries to enable them to pay the tax. And if the employer does take a generous view of the case and raise their salaries, the contribution to the Fund does not cease to be a tax. It is always a tax, and is always a very good excuse for asking for increase of salary.

Now where there is taxation, there should always be representation; and the staff are generally invited to elect representatives as managers of the Fund, the employers nominating the trustees and reserving to themselves certain powers. The men, starting with the idea that they are never likely to live to 65, want to arrange to have their money back somehow. If they could have a pension at 50 or 55, or even 60, that might make a difference; but, even then, they would like to have their money back if they did not live to get a pension. This, then, is the kind of reasoning which takes place: Firstly, “Suppose we leave the service, it would not be right or just that you should keep our subscriptions”; and it is agreed that, on leaving the service, the member’s own subscriptions shall be returned to him without interest. Secondly, “What is to happen if we die before reaching the pension age? My wife and family ought to have the benefit of the Fund”; and so it is agreed that in case of death before the pension age, the employer’s and his own subscriptions shall be returned without interest, or his own subscriptions with compound interest shall be paid over, or both his own and employer’s subscriptions with compound interest shall be paid out. Thirdly, “Suppose a man has to retire through ill-health before the pension age, what is to be

"done for him"? Well, he might be treated in the same way as if he died; or he may have his pension according to scale. Fourthly, "But then a man might die directly he reaches the pension age, or after he has only received his pension for one year; it would not be fair to his family that all his subscriptions for a lifetime should be left in the Fund." And so it is agreed that if a member dies before his pension receipts amount to what he has paid, the balance shall be paid to his family.

The above are the principal provisions found in the Rules; and if they are not there already, you may be perfectly certain that they soon will be. Sometimes there will be a provision that no return is to be made if the member leaves the service within five years, and no retiring allowance until after ten years; and occasionally minimum and maximum pensions are fixed. The last is not a bad provision where there are one or two highly paid individuals whose contributions would provide but an insignificant portion of their pensions according to scale. The men are, as a rule, generously inclined towards those of their comrades who break down in the service, and will sometimes provide that if a man has to retire after ten years' service it shall be counted as 15 for the purpose of calculating his pension; after 15 years, he shall be treated as if he had subscribed for $17\frac{1}{2}$ years, and so on. These I call excrescences, and must, as a rule, be dealt with separately.

As to the scale of pension, it is always based on years of service, and generally on average salary, but sometimes on salary for last year, or the average of the last three years. It is quite evident that all these numerous provisions for the return of contributions must decrease the pension which otherwise could be given. However, we are not concerned with the ethics of the subject; we have to find out how to value the various benefits, and what pension the Fund will afford, after making these numerous provisions.

ELEMENTARY PROBLEMS.

Leaving the question of salary out of consideration for the present, we will start with the investigation of some of the problems on the basis of a fixed contribution or a fixed pension of 1 per annum.

We have now no use for Table 2, but we can still use Tables 3 and 4 to show the difference when early retirements are allowed for or not.

In all these problems we shall follow the usual rule in all our elementary work, of assuming that the deaths, withdrawals and retirements take place at the end of the year.

Problem IA.—What is the present value at age x of the return of 1 per annum, without interest, on death, withdrawal or early retirement before age 65?

This is evidently the present value of an assurance of 1 for the first year, increasing by 1 per annum up to age 65 for the respective modes of exit; so that if we have columns of ${}^dC_x = v^{x+1}d_x$ *, ${}^wC_x = v^{x+1}w_x$ and ${}^rC_x = v^{x+1}r_x$, and sum these upwards commencing with the values for $x=64$, thus producing columns which we will call dM_x , wM_x and rM_x , and sum these again upwards, producing columns which we will call dR_x , wR_x and rR_x , the present value at age x of the return of the contributions of 1 per annum in respect of death before 65, will be $\frac{{}^dR_x}{D_x}$; in respect of withdrawal, $\frac{{}^wR_x}{D_x}$; and in respect of early retirement, $\frac{{}^rR_x}{D_x}$, or rather we should say, with regard to the last, that that would be the value when there are retirements at age x .

If, as is likely to be the case with regard to the early retirements, there is an interval before the first retirement, say n years, then as n contributions will have accumulated, the present value, at age x , of the return in respect of retirements will be $(n \cdot {}^rM_{x+n} + {}^rR_{x+n}) \div D_x$ or $\{(n+1) \cdot {}^rM_{x+n} + {}^rR_{x+n+1}\} \div D_x$.

If no return is to be made in the event of withdrawal during the first five years, then the value of the benefit, at the moment of entering the Fund at age x , will be $(5 \cdot {}^wM_{x+5} + {}^wR_{x+5}) \div D_x$; and the same will apply *mutatis mutandis* to the other modes of exit.

So far, the value of the extended benefits do not present any difficulty, but if the contributions are to be returned with

* As we are now about to make a number of new columns calculated on new functional values and with new combinations, it is necessary to have new symbols to distinguish them. To avoid the use of new letters, where the columns are of a similar character to those in use, it is proposed to use the old symbols, D, N, C, M, R, with an index showing the table on which the calculations are made, and a prefix, on the top left-hand corner, to show the function on which the columns are based. Although dC_x above, is the same as the ordinary C_x , dM_x and dR_x are adopted to show that they are not the ordinary columnar values, but the results of summations from age 64 only. ${}^dM_x = M_x^{(4)} - M_{65}^{(4)}$ and ${}^dR_x = R_x^{(4)} - R_{65}^{(4)} - (65-x)M_{65}^{(4)}$.

compound interest on death or early retirement, a somewhat new and interesting problem is presented for investigation.

Problem II.A.—What is the present value of the accumulations of an annuity of 1 to the end of the year of death or early retirement before the age of 65, when the rate of accumulation is the same as the rate of discount used in the valuation?

Now the present value of the accumulations of an annuity-certain is the same as the present value of an annuity-certain, when the rate of interest is the same as the rate of discount; hence in respect of l_x , persons living at age x , the present value of the payments in respect of the deaths which occur before the age of 65 will be

$$a_{\overline{1}|}d_x + a_{\overline{2}|}d_{x+1} + a_{\overline{3}|}d_{x+2} + \dots + a_{\overline{65-x}|}d_{64}.$$

Separating these into their elements we have

$$\begin{array}{rcccc} a_{\overline{1}|}d_x & = & v d_x & & \\ a_{\overline{2}|}d_{x+1} & = & v d_{x+1} + v^2 d_{x+1} & & \\ a_{\overline{3}|}d_{x+2} & = & v d_{x+2} + v^2 d_{x+2} + v^3 d_{x+2} & & \\ \vdots & & \vdots & & \vdots \end{array}$$

And summing these we have $v l'_x + v^2 l'_{x+1} + v^3 l'_{x+2} + \dots + v^{65-x} l'_{64}$

These l 's, however, are not the living in our Hypothetical Experience Tables, because the d 's there are not the decrements of the living, and we shall therefore have to make a special l_x column by summing the d 's upwards commencing with d_{64} . This column we shall distinguish by adding a dash to the ordinary symbol.

The value of the benefit at age x will therefore be

$$\frac{1}{l'_x} (v l'_x + v^2 l'_{x+1} + v^3 l'_{x+2} + \dots + v^{65-x} l'_{64})$$

Equating to a denominator of D_x , we have

$$\frac{1}{v^x l'_x} (v^{x+1} l'_x + v^{x+2} l'_{x+1} + v^{x+3} l'_{x+2} + \dots + v^{65} l'_{64}).$$

If we were to call $v^x l'_x = D'_x$, the value would be represented by

$$\frac{1}{D'_x} (v D'_x + v D'_{x+1} + v D'_{x+2} + \dots + v D'_{64})$$

and summing the values of $v D'_x$ like the N column from age 64 upwards and calling the result $v \cdot N'_{x-1}$, the value of the benefit would be represented by

$$\frac{v \cdot N'_{x-1}}{D_x},$$

so that if there were no withdrawals or retirements, in fact, if we were using an ordinary mortality table with no limitation as to age, the value would be $(1 + a_x)$ discounted for one year; which is perfectly correct, since the present value of the accumulations of an annuity-due is $(1 + a_x)$, and we have been valuing the same benefit only deferred one year (see *J.I.A.* xxiii, 244).

As we propose to tabulate the values of $v \cdot D'_x$ and $v \cdot N'_{x-1}$, it will be desirable, in order to avoid the use of the v , which might lead to confusion (being mistaken, perhaps, for some operation to be performed), to use distinctive and representative symbols; and we shall therefore adopt dD_x and dN_x ,* so that

$${}^dD_x = v^{x+1} l'_x, \text{ and } {}^dN_x = \sum_x^{64} v^{x+1} l'_x = \sum_x^{64} v \cdot D'_x = v \cdot N'_{x-1}.$$

The value of the benefit will henceforth be represented by $\frac{{}^dN_x}{D_x}$.

To find the value of a similar benefit on early retirement, we require to construct similar columns from the r 's, and the value will be represented by $\frac{{}^rN_x}{D_x}$.

The Tables for valuing these benefits will be found on page 268

If there is to be an interval before any return is to be granted, say 5 years, the value at the age at entrance x will be

$$\frac{1}{l_x} [(1+i)^5 + (1+i)^4 + (1+i)^3 + (1+i)^2 + (1+i) + 1] \{ v^6 l'_{x+5} + v^7 l'_{x+6} + \dots \}$$

since the contributions of 1 per annum will be accumulating at compound interest,

$$= \frac{1}{v^x l_x} [\{ (1+i)^5 + (1+i)^4 + (1+i)^3 + (1+i)^2 + (1+i) + 1 \} v \cdot D'_{x+5} + v \cdot D'_{x+6} + \dots]$$

If now we call $a_{(n)}$ the amount of an annuity-certain for n years, the above value will be represented by the formula

$$(a_{(6)}, {}^dD_{x+5} + {}^dN_{x+6}) \div D_x,$$

and, generally, if there is an interval of n years before the benefit

* If there were any necessity to distinguish the limiting age, as may possibly happen sometimes, such age might be put as a prefix at the bottom of the symbol, thus, ${}^d_{64}N_x$, but, as there is only one limiting age throughout the whole of this paper and the formulas are general, I see no advantage in complicating the notation.

commences or can arise, the value of the benefit will be represented by the formula

$$\frac{a_{x+n+1} \cdot {}^dD_{x+n} + {}^dN_{x+n+1}}{D_x}.$$

The same formula with the substitution of the prefix r for d , will apply to early retirements, where there is an interval before the first retirement takes place according to the Experience Tables.

NOTE.—If the accumulations are at a different rate of interest to that used in the valuation, then a formula to be found in the *Journal*, xxiii, p. 244, would have to be suitably substituted.

Problem IIIA.—What is the present value of an annuity on early retirement (before age 65), equivalent in amount to the sum of 1 per annum (without interest) from entrance until retirement?

In other words, if a person now aged x contributes 1 per annum to a Fund, what would be the present value of an annuity of the sum of his contributions on retirement before age 65?

Adopting the usual method of analysis, we say, out of l_x persons living at the age x , r_x will receive an annuity of 1; r_{x+1} an annuity of 2; r_{x+2} an annuity of 3; and so on. These annuities will be the annuities according to the invalid retirement scale which we will call a'_x .

The present value of all these annuities will evidently be

$$(r_x \cdot a'_{x+1})v + (2r_{x+1} \cdot a'_{x+2})v^2 + (3r_{x+2} \cdot a'_{x+3})v^3 + \dots$$

which being divided by l_x would give the present value for each person at age x .

Equating these values to a denominator of D_x , we have the value

$$= \frac{1}{l_x v^x} (r_x v^{x+1} \cdot a'_{x+1} + 2r_{x+1} v^{x+2} \cdot a'_{x+2} + 3r_{x+2} v^{x+3} \cdot a'_{x+3} + \dots).$$

$r_x v^{x+1}$ has already been tabulated and called rC_x , and we want now to multiply each value of rC_x by the corresponding annuity a'_{x+1} . We shall then have a series of values of ${}^rC_x \cdot a'_{x+1}$. A first summation of these values, from age 64 upwards, would give us the column for finding the value of an annuity of 1 on retirement, and, for distinction, I propose to call this column raM_x . A second summation will give us the value

within the bracket, and this column we will call nR_x . Hence, for the above value, we shall have the convenient formula $\frac{{}^nR_x}{D_x}$.

If there is an interval before retirement begins or is allowed (say n years), the value will be

$$\frac{n \cdot {}^nM_{x+n} + {}^nR_{x+n}}{D_x} \quad \text{or} \quad \frac{(n+1) \cdot {}^nM_{x+n} + {}^nR_{x+n+1}}{D_x}.$$

The tables for valuing these benefits will be found on page 269.

With all the Tables we have so far constructed, we are able to solve, in an elementary way, some of the problems connected with Pension Funds; and, where applicable, to show by examples the difference in the results according to the differently constructed Experience Tables.

Problem IV.A.—What is the annual premium, due at the beginning of the year but payable at the end of the year, to provide an annuity of $65-x$ at the age of 65.

$$\text{This is evidently } \frac{(65-x)N_{65}}{r(N_{x-1}-N_{64})} = \frac{(1+i)(65-x)N_{65}}{N_{x-1}-N_{64}}.$$

TABLE B, illustrating Problem IV.A.

Age x	VALUES ACCORDING TO		
	Table 2	Table 3	Table 4
15	1.406	.807	.481
20	1.638	1.172	.702
25	1.909	1.559	.938
30	2.227	1.976	1.198
35	2.604	2.437	1.494
40	3.055	2.960	1.841
45	3.603	3.563	2.263
50	4.281	4.270	2.799
55	5.135	5.130	3.552
60	6.242	6.242	4.752

Problem V.A.—What is the annual premium, due at the beginning of the year but payable at the end of the year, to provide an annuity of $65-x$ at the age of 65, with the condition that the whole of the premiums paid, without interest, shall be returned at the end of the year of death, in the event of death before 65.

Here, $P.v(N_{x-1} - N_{64}) = (65 - x)N_{65} + P.^dR_x$

Hence,
$$P = \frac{(65 - x)N_{65}}{v(N_{x-1} - N_{64}) - ^dR_x}$$

or, if dR_x has not been calculated, as in Tables 2 and 3, we have

$$P = \frac{(65 - x)N_{65}}{v(N_{x-1} - N_{64}) - \{R_x - R_{65} - (65 - x)M_{65}\}}.$$

TABLE C, illustrating Problem VA.

Age x	VALUES ACCORDING TO		
	Table 2	Table 3	Table 4
15	1.766	.928	.542
20	2.088	1.402	.816
25	2.467	1.929	1.121
30	2.911	2.511	1.459
35	3.428	3.156	1.846
40	4.023	3.867	2.289
45	4.699	4.633	2.802
50	5.446	5.430	3.410
55	6.252	6.245	4.175
60	7.076	7.078	5.309

Problem VIA.—What is the annual premium for the same benefits as in Problem VA, with the additional condition that the premiums paid, without interest, shall be returned, to those who withdraw, at the end of the year of withdrawal.

Here, $P.v(N_{x-1} - N_{64}) = (65 - x)N_{65} - P(^dR_x + ^wR_x)$

and
$$P = \frac{(65 - x)N_{65}}{v(N_{x-1} - N_{64}) - ^dR_x - ^wR_x}$$

or, if the column dR_x has not been calculated

$$P = \frac{(65 - x)N_{65}}{v(N_{x-1} - N_{64}) - \{R_x - R_{65} - (65 - x)M_{65}\} - ^wR_x}$$

Problem VIIA.—What is the annual premium for the same benefits as in Problem VIA, with the addition of a return of all the premiums paid on early retirement (before 65).

The formula is evidently
$$P = \frac{(65 - x)N_{65}}{v(N_{x-1} - N_{64}) - ^dR_x - ^wR_x - ^rR_x}.$$

TABLE D, illustrating Problems VIA and VIIA.

Age x	VALUES FOR PROBLEM VIA		VALUES FOR PROBLEM VIIA
	Table 3	Table 4	Table 4
15	1.479	.858	.971
20	1.888	1.093	1.278
25	2.333	1.350	1.632
30	2.828	1.641	2.054
35	3.384	1.976	2.563
40	4.002	2.369	3.181
45	4.689	2.837	3.927
50	5.438	3.415	4.818
55	6.245	4.175	5.849
60	7.078	5.309	6.942

Problem VIII A.—What is the annual premium* to provide an annuity of $(65-x)$ at the age of 65, a return of all the premiums without interest on withdrawal, and a return of all the premiums, with 4 per-cent compound interest, on death before 65.

$$\text{Here, } P.v(N_{x-1} - N_{64}) = (65-x)N_{65} + P({}^wR_x + {}^dN_x)$$

$$\text{Hence, } P = \frac{(65-x)N_{65}}{v(N_{x-1} - N_{64}) - {}^wR_x - {}^dN_x}$$

Problem IX A.—What is the annual premium to provide for the benefits in Problem VIIA with the addition of a return of all the premiums accumulated at 4 per-cent compound interest on retirement before 65.

If x is equal to or greater than age 28, the age when the first retirement occurs in the tables, then

$$P.v(N_{x-1} - N_{64}) = (65-x)N_{65} + P({}^wR_x + {}^dN_x + {}^rN_x).$$

$$\text{Hence, } P = \frac{(65-x)N_{65}}{v(N_{x-1} - N_{64}) - ({}^wR_x + {}^dN_x + {}^rN_x)}.$$

But if x is less than 28, then we must substitute for rN_x

$$a_{:29-x:} \cdot {}^rD_{28} + {}^rN_{29}.$$

Problem X A.—What is the annual premium to provide an annuity of $65-x$ at the age of 65, a return of all the premiums paid without interest on withdrawal, a return of all the premiums

* I shall not repeat that the annual premium is due at the beginning but paid at the end of the year, or that the benefits are payable at the end of the year of exit. That is to be understood throughout the paper.

paid with 4 per-cent compound interest on death before 65, and an annuity for the remainder of life of 1 per annum, for every year entered upon, to those who retire from ill-health before 65.

If x is equal to or greater than 28, then

$$P.v(N_{x-1} - N_{64}) = (65-x)N_{65} + P({}^wR_x + {}^dN_x) + {}^{ra}R_x$$

and
$$P = \frac{(65-x)N_{65} + {}^{ra}R_x}{v(N_{x-1} - N_{64}) - ({}^wR_x + {}^dN_x)}.$$

If x is less than 28, we must substitute for ${}^{ra}R_x$

$$(28-x){}^{ra}M_{28} + {}^{ra}R_{28}.$$

Problem XI A.—What is the annual premium to provide the benefits in Problem VIII A, with the further condition that if the annuitant dies after the age of 65 and before the annuity payments amount to the total premiums without interest, the difference shall be paid to his family?

Here the annuity is fixed, so that we have to find another P , which we will call \mathbb{P} . Now the total payments of \mathbb{P} will be $(65-x)\mathbb{P}$, and the annuity being $(65-x)N_{65}$, we can dispense with the factor $(65-x)$ and consider how much N_{65} has to be increased with reference to \mathbb{P} . From Problem I in my paper in the *Transactions* of the Second Actuarial Congress, we find that N_{65} must be increased by $\mathbb{P}M_{65} + R_{66+\mathbb{P}} - R_{66}$, and the formula will therefore be

$$\mathbb{P} = \frac{(65-x)(N_{65} + \mathbb{P}M_{65} + R_{66+\mathbb{P}} - R_{66})}{v(N_{x-1} - N_{64}) - {}^wR_x - {}^dN_x},$$

which does not look a very promising working formula. But we can change the numerator into

$$(65-x)N_{65} \cdot \frac{1}{N_{65}} (N_{65} + \mathbb{P}M_{65} + R_{66+\mathbb{P}} - R_{66}),$$

by which means our formula will be converted into

$$\mathbb{P} = \frac{P}{N_{65}} (N_{65} + \mathbb{P}M_{65} + R_{66+\mathbb{P}} - R_{66})$$

$$\mathbb{P} \cdot N_{65} = P \cdot \mathbb{P}M_{65} + P(N_{65} + R_{66+\mathbb{P}} - R_{66})$$

$$\mathbb{P} \cdot (N_{65} - \mathbb{P}M_{65}) = P(N_{65} + R_{66+\mathbb{P}} - R_{66})$$

and

$$\mathbb{P} = \frac{N_{65} - R_{66} + R_{66+\mathbb{P}}}{\frac{1}{P}N_{65} - M_{65}}$$

a formula which is easily calculated, because there is only one term which varies with \mathbb{P} .

Problem XIIA.—What is the annual premium to provide the benefits in Problem *XA*, with the further condition that if the annuitant dies after he has entered on his annuity, whether before or at 65, but before the annuity payments amount to the total premiums he has paid, without interest, the difference shall be paid to his family?

This Problem is far too complicated for us to attempt to produce an exact solution, for we should have to operate upon the annuities for each possible age of retirement. As, however, the value of the annuity at any age at retirement does not vary very much from the value of an annuity at age 65, I think we may fairly assume that all the annuities would increase alike in liability. The difference would depend then mainly upon how far the relative values of M_x , R_x , and $D_x \cdot a'_x$, by the Table for invalid pensioners, differ from the relative values of M_{65} , R_{65} , and N_{65} . I think we may assume that the difference would be small.

Formula *XA* will then become

$$\mathbb{P} = \frac{\left\{ (65-x) + \frac{{}^a R_x}{N_{65}} \right\} (N_{65} + \mathbb{P} M_{65} + R_{66+\mathbb{P}} - R_{66})}{v(N_{x-1} - N_{61}) - ({}^w R_x + {}^d \mathbb{P} x)}$$

and the numerator can be converted into

$$\left\{ (65-x) N_{65} + {}^a R_x \right\} \frac{1}{N_{65}} \cdot (N_{65} + \mathbb{P} M_{65} + R_{66+\mathbb{P}} - R_{66}),$$

and we shall again have

$$\mathbb{P} = \frac{P}{N_{65}} (N_{65} + \mathbb{P} M_{65} + R_{66+\mathbb{P}} - R_{66})$$

the same as in *XIA*, and, consequently,

$$\mathbb{P} = \frac{N_{65} - R_{66} + R_{66+\mathbb{P}}}{\frac{1}{P} N_{65} - M_{65}}$$

the same formula as in the preceding problem. So that when P is known, and it will always be necessary to find P first, \mathbb{P} can be easily found.

TABLE E, illustrating Problems VIIIA, IXA, XA, and XIA, all by Table A.

Age x	Problem VIIIA	Problem IXA	Problem XA	Problem XIA *
15	1.084	1.750	2.321	2.35
20	1.363	2.331	2.882	2.93
25	1.647	2.905	3.422	3.50
30	1.945	3.474	3.955	4.07
35	2.270	4.036	4.489	4.66
40	2.636	4.603	5.025	5.28
45	3.059	5.180	5.567	5.93
50	3.578	5.777	6.113	6.63
55	4.273	6.428	6.673	7.41
60	5.341	7.120	7.236	8.15

* These values provide for the benefits in Problem XA, with the addition of a return of the excess of contributions over pension payments in the case of those only who reach the age of 65.

With the Tables we have constructed, any number of combinations can be formed; but we will deduce a formula for one which is not uncommonly found in practice.

Problem XIII A.—What is the annual premium to provide an annuity of $(65-x)$ at age 65, a return of all the premiums paid with 4 per-cent compound interest on death before 65; on withdrawal within 5 years no return, but on withdrawal after 5 years, half the premiums without interest to be returned; on retirements from invalidity before 15 years' service, the premiums paid with compound interest to be returned, but on retirement after 15 years' service an annuity of 1 for every year entered upon.

This is the same as Problem XA, with variations; thus, for wR_x we must substitute $\frac{1}{2}(5^wM_{x+5} + {}^wR_{x+5})$, and for aR_x we must substitute

$$({}^rN_x - {}^rN_{x+15} - 15 \cdot {}^rD_{x+15}) + (15 {}^aM_{x+15} + {}^aR_{x+15})$$

making the proper substitute for rN_x when x is less than the age when the first retirement takes place.

The equation is therefore

$$P.v(N_{x-1} - N_{64}) = (65-x)N_{65} + P.\frac{1}{2}(5^wM_{x+5} + {}^wR_{x+5}) + P.{}^dN_x \\ + P({}^rN_x - {}^rN_{x+15} - 15 \cdot {}^rD_{x+15}) + 15 {}^aM_{x+15} + {}^aR_{x+15}$$

Hence

$$\frac{(65-x)N_{65} + 15 {}^aM_{x+15} + {}^aR_{x+15}}{v(N_{x-1} - N_{64}) - \frac{1}{2}(5^wM_{x+5} + {}^wR_{x+5}) - {}^dN_x - ({}^rN_x - {}^rN_{x+15} - 15 \cdot {}^rD_{x+15})}$$

and if, in addition, it is desired to add the condition that if after the annuity is entered upon, the payments do not amount to all the premiums paid without interest, the difference is to be returned, you must find $\bar{a}_{\overline{n}|i}$ by the formula in Problem XIIA.

The last formula will give some idea of the nature of the problems to be dealt with.

ADVANCED PROBLEMS, INTRODUCING THE ELEMENT OF SALARY.

Hitherto we have been considering the numerous problems arising out of these Funds from a theoretical standpoint; but our time has not been wasted, as the tables we have already calculated will be the starting point for new combination Tables, now that we are going to take up the practical side of the subject.

In practice the contributions are not a fixed annual sum, but a percentage of the salary received in each year, and are generally deducted from the monthly or quarterly salaries. The pension is no longer a fixed and known quantity, but is based upon a common scale, the amount varying only according to the number of years of service and the average salary throughout the whole period; or, instead of average salary, it may be dependent on the last yearly salary, or an average of the salary for the last 3 or 5 years; but is independent of the age at entry. As a rule, it is that common scale which has to be determined by the actuary.

At the first blush, it would seem to be almost impossible to find the present value of an annuity increasing irregularly according to the unknown future increases in a salary, extending over 40 or 50 years, or to determine beforehand what the salary is likely to be at the end of that time, or what the average salary will be throughout the period; and so undoubtedly it would be if we had to deal only with individual cases. But when the staff is large and contributions are compulsory, we can deal with averages, and so arrive, *on the average*, at very close results.

By tabulating the salaries paid to all persons at every age for a period of 5 or 10 years, a Table of average salary at each age can be formed. These will generally form a very irregular series, particularly at the higher ages, owing to the higher paid officials being of an age when there are not sufficient of the ordinary staff to make an average. The introduction of a highly paid official from outside will often upset the financial stability of these Funds.

Our object at present, however, is not so much to find out what the present salaries are, but to find out what the average salary of the present staff is going to be; and that, not with the view of determining an average salary at the end of the period, but, as will be seen presently, to find the average annual increase in the salaries.

Having obtained our data and formed our series, we proceed to make an intelligent graduation, using our discretion, particularly in the case of a young institution, to modify the high salaries by the assumption that a certain number of the younger members of the staff will be in receipt of much lower salaries when they arrive at the higher ages.

In Table 12, column 2, is a series purporting to represent the average salary at each age received by the staff of such a concern as a railway company or large factory. Now let us clearly understand what this table means, or does not mean. It does not mean that the survivors of those now of the age of 15 will, when they reach the age of 30, be each receiving a salary of £90. It may be that some will be receiving £75 or £80, some £100, and one perhaps £300 (see details on page 270), but they will, altogether, on the average, be receiving £90. Similarly, with regard to the survivors at age 40; the £300 salary at age 30 may have increased to £450, a salary of £120 may have increased to £250, but then some of the salaries may only have increased to £95 or £100, but, taken altogether, they form an average of £130. Now, if we know the ratio of average increase from age 30 to age 40, we can, by multiplying all the individual salaries at age 30 by that ratio, find the average of the salaries taken altogether at age 40. Hence, if we have a table of ratios for each age, and we apply them to the salary of each individual at that age, we shall, when we take the whole together at all ages, arrive at the most probable future income of the Fund, and the most probable average liability.

Our object now must be to equate everything to a salary of 1 at any age x ; in other words, we want a series of multipliers, which, when multiplied into the salaries at age x , will give us results which, when all are summed together, will be the most probable on the average.

We will, as before, make our investigations step by step, and we shall use the same assumptions, namely, that the ages are exact ages; that a whole year's contribution is due at the beginning of the year, but paid at the end of the year; that

those who die, withdraw, or retire, do so at the end of the year; and, further, that the increase of salary always takes place at the exact age.

As all contributions are a percentage of salary, we can leave out "percentage" and deal with full salary.

Problem IB.—To find a multiplier for age x , which, when multiplied into the salary at age x , will give the present value of the total salary receivable up to age 65.

Let s_x be the salary for one year at age x . Then, as the salary is due at the beginning of the year but payable at the end of the year, the present value of 1 of salary for one year will be $\frac{s_x v}{s_x}$. Equating this to a denominator of D_x we have $\frac{v s_x D_x}{s_x D_x}$.

The present value of the second year's salary of 1 increased according to scale will be $\frac{v \cdot s_{x+1} D_{x+1}}{s_x D_x}$; and the present value of all future salaries, starting with 1 and increasing according to scale will be

$$\frac{v(s_x D_x + s_{x+1} D_{x+1} + s_{x+2} D_{x+2} + \dots + s_{64} D_{64})}{s_x D_x}$$

so that if we have a column of $s_x D_x$ for every age up to 64 inclusive, and sum it like the \mathbb{N}_x column, and multiply each value in this column by v , we shall at once have the means of solving the problem.

Let us call $s_x D_x = D_x^s$, and the constant summation multiplied by v , \mathbb{N}_x^s , * then our multiplier will be represented by $\frac{\mathbb{N}_x^s}{D_x^s}$.

Our next object is to find a formula for ascertaining the present value of a pension at age 65 equated to 1 of salary at present age. This, however, must depend upon the way in which the pension is to be calculated. The principal ways are (i) according to average salary and number of years of service, and (ii) according to last salary, or average of last two or three years' salary and number of years of service: the former being, I believe, the more common.

* I have purposely omitted the v in this symbol for the same reason as before, namely, to avoid confusion, as its appearance in a formula might be taken to indicate an operation to be performed, while the use of a single symbol with the index s , shows that it is a value from a specially constructed column.

Problem IIb.—To find the present value, at age at entrance x , of a pension at age 65 based on average salary and number of years of service, equated to a salary of 1 at age x .

Since average salary is total salary divided by the number of years service, it follows that any scale based on average salary and number of years service can be converted into a percentage of total salary. Thus, $\frac{1}{60}$ th of average salary for every year of service, say n years, would be $\frac{n}{60}$ th of average salary. But

average salary is total salary divided by n , so that $\frac{n}{60}$ of average salary = $\frac{n}{60} \times \frac{\text{total salary}}{n} = \frac{1}{60}$ of total salary or $1\frac{2}{3}$ per-cent of

total salary. When we have ascertained the pension in terms of a percentage of total salary, we can turn it into any denomination we like. For instance, $1\frac{2}{3}$ per-cent of total salary is $\frac{5}{3} \times \frac{1}{100}$ of $\frac{1}{60}$ th of average salary, or $\frac{5}{6}$ th of $\frac{1}{60}$ th of average salary for each year of service. Percentage of total salary is percentage of average salary multiplied by the number of years service. When the pension, therefore, is based on average salary and number of years service, all our calculations will be based on total salary.

Now total salary from age x to 65, equated to 1 of salary at age x , will be

$$\frac{s_x + s_{x+1} + s_{x+2} + \dots + s_{64}}{s_x} = \frac{\Sigma s_x}{s_x}$$

and the present value of an annuity at age 65 of total salary for every 1 of salary at age x , will evidently be

$$\frac{\Sigma s_x \cdot N_{65}}{s_x \cdot D_x} = \frac{\Sigma s_x N_{65}}{D_x^s}$$

Problem IIIb.—To find the present value, at age at entrance x , of a pension at age 65, based on last average salary and number of years service, equated to a salary of 1 at age x .

The last salary being s_{64} , and the number of years service being $(65-x)$, the present value of the pension will be

$$\frac{(65-x)s_{64} \cdot N_{65}}{s_x \cdot D_x} \quad \text{or} \quad \frac{(65-x)s_{64} \cdot N_{65}}{D_x^s}$$

Similarly, for a basis of average of last three years' salary, the formula will be

$$\frac{(65-x)\frac{1}{3}(s_{62} + s_{63} + s_{64})N_{65}}{D_x^s}$$

It will be necessary, therefore, to have Tables of Σs_x and $\frac{s_{64}}{s_x}$.

Problem IVB.—What annuity, based on total salary, could be given to the survivors at age 65, for a contribution of 5 per-cent of salaries paid by all of the age x at entrance?

Let us take a concrete case, say $x=20$, and salary at age $x=60$.

Five per-cent of 60 is 3, therefore the present value of 5 per-cent of all the salaries will, on the average, be

$$\frac{3 \sum_{20}^s}{D_{20}^s}.$$

The annuity, which is unknown, we will call X . The present value of an annuity of X at age 65 based on total salary (Problem IIB) will be

$$X \cdot \frac{60 \sum_{20}^s N_{65}}{D_{20}^s}.$$

Equating the payments and benefits, we have

$$\frac{3 \sum_{20}^s}{D_{20}^s} = X \cdot \frac{60 \sum_{20}^s N_{65}}{D_{20}^s}$$

and

$$X = \frac{3 \sum_{20}^s}{60 \cdot \sum_{20}^s N_{65}} = \frac{.05 \sum_{20}^s}{\sum_{20}^s N_{65}}$$

which is independent of the amount of salary; and we can say generally that our problem is solved by the equation

$$X = \frac{.05 \sum_{20}^s}{\sum_{20}^s N_{65}}.$$

The number of years service is $(65-x)$, so that if we multiply X by $(65-x)$ the result will be the proportion of average salary; and if we wish to equate this to, say $\frac{1}{60}$ th of average salary for every year of service, we say it is $(X \times 60)$ parts of $\frac{1}{60}$ th of average salary for every year of service.

To give a proper illustration, by examples, of these values, we ought to use our Table No. 3, where there are no retirements before age 65, and make certain adjustments in the formula, which will be explained later.

Problem VB.—To find the present value, at age at entrance x , of the return of total salary, without interest, on withdrawal, death, or retirement, equated to 1 of salary at age x .

Out of l_x persons entering at age x , at a salary of s_x , w_x will withdraw in the first year and take out $w_x s_x$. In the second

year w_{x+1} will withdraw, and take out $w_{x+1}s_x + w_{x+1}s_{x+1}$. In the third year w_{x+2} will withdraw, and take out $w_{x+2}(s_x + s_{x+1} + s_{x+2})$, and so on. The present value of these withdrawals will be

$$\begin{array}{ccc} v w_x s_x & & \\ v^2 w_{x+1} s_x + v^2 w_{x+1} s_{x+1} & & \\ v^3 w_{x+2} s_x + v^3 w_{x+2} s_{x+1} + v^3 w_{x+2} s_{x+2} & & \\ \vdots & \vdots & \vdots \end{array}$$

Equating these values to a denominator of $l_x \cdot v^x \cdot s_x$, their sum will be

$$\Sigma_x (v^{x+1} \cdot w_x) s_x + \Sigma_{x+1} (v^{x+2} \cdot w_{x+1}) s_{x+1} + \Sigma_{x+2} (v^{x+3} \cdot w_{x+2}) s_{x+2} + \dots$$

So that by first forming a Table of $v^{x+1} w_x$ and summing the values like the M column, and calling these values ${}^w M_x$, a column which has already been tabulated; then multiplying each value of ${}^w M_x$ by s_x , calling the result ${}^w M_x^s$, and then, summing these values again, thus producing a column which we will call ${}^w R_x^s$, we shall have, as the value of the return of total salary, without interest, to those who withdraw, equated to 1 of salary at age at entrance x ,

$$\frac{{}^w R_x^s}{{}^w D_x^s}.$$

By constructing similar columns for the other modes of exit, based on the columns of ${}^d M_x$ and ${}^r M_x$ already constructed, and calling the new values, ${}^d M_x^s$, ${}^d R_x^s$ and ${}^r M_x^s$ and ${}^r R_x^s$, we shall have the necessary means for valuing the return of total salary, without interest, on death and early retirement.

If there is an interval before the return can commence, as in the case of retirements when we are dealing with an age earlier than 28, or if no return is made on withdrawal before a certain number of years service, say n , then the value will be

$$\frac{(s_x + s_{x+1} + \dots + s_{x+n-1}) {}^w M_{x+n} + {}^w R_{x+n}^s}{{}^w D_x^s}$$

or
$$\frac{(s_x + s_{x+1} + \dots + s_{x+n}) {}^w M_{x+n} + {}^w R_{x+n+1}^s}{{}^w D_x^s}$$

(see Problem I A, page 218).

Problem VI B.—What proportion of total salary can be given as a pension at age 65 for a contribution of 5 per-cent of salary,

with the condition that on death or withdrawal or retirement before 65, the total contributions shall be returned without interest?

Equating the payments and benefits, we have

$$.05\overline{11}_x^s = X \cdot \Sigma s_x N_{65} + .05({}^dR_x^s + {}^wR_x^s + {}^rR_x^s)$$

$$\therefore X = \frac{.05\{\overline{11}_x^s - ({}^dR_x^s + {}^wR_x^s + {}^rR_x^s)\}}{\Sigma s_x N_{65}}$$

If x is less than 28, then $(\Sigma s_x - \Sigma s_{28}) {}^rM_{28} + {}^rR_{28}^s$ must be substituted for ${}^rR_x^s$.

TABLE F, illustrating Problems IV_B and VI_B for a Contribution of 5 per-cent of Salary.

Age at Entrance x	PENSION AT AGE 65 ONLY, FOR 5% OF SALARY. PROBLEM IV _B			PENSION AT 65, AFTER ALLOWING FOR RETURN OF CONTRIBUTIONS ON DEATH, WITHDRAWALS, AND EARLY RETIREMENT, FOR 5% OF SALARY. PROBLEM VI _B		
	Percentage of		Parts of 1 st of of Average Salary for every year of service	Percentage of		Parts of 1 st of of Average Salary for every year of service
	Total Salary	Average Salary		Total Salary	Average Salary	
15	5.69	284.5	3.41	3.07	153.5	1.84
20	4.91	221.0	2.95	2.76	124.2	1.66
25	4.16	166.4	2.50	2.40	96.0	1.44
30	3.51	122.9	2.11	2.05	71.8	1.23
35	2.97	89.1	1.78	1.73	51.9	1.04
40	2.50	62.5	1.50	1.45	36.3	.87
45	2.12	42.4	1.27	1.21	24.2	.73
50	1.73	26.0	1.04	1.01	15.2	.61
55	1.39	13.9	.83	.85	8.5	.51
60	1.05	5.3	.63	.72	3.6	.43

Adjustments.

I think it would be as well, at this point, to consider the question of adjustments before our problems become more complicated.

First, then, with regard to the annuity at age 65. As only those who survive the age of 65 will enter on the annuity, each will have subscribed on their full yearly salaries from age at entrance to age 65, so that the factor Σs_x is absolutely correct. N_{65} , however, assumes that the annuities are to be paid yearly instead of quarterly or monthly as in practice; and if we assume that the present value of the annuity at age 65 would be $a_{65} + \frac{1}{2}$, approximately, N_{65} will become $N_{65} + \frac{1}{2}D_{65}$.

Now with regard to the payments or contributions in Problem IVB. Here we have two assumptions which require correction. In the first place, it is assumed that the contributions are paid in full for every year up to the end of the year of exit, whether it be by death, withdrawal, early retirement or superannuation; but, with the exception of those who are superannuated at 65, this gives an income too great by half-a-year's contribution in the year of exit, on the average. N_x^s will therefore have to be diminished by

$$\frac{1}{2} [\sum_x^{64} (v^{x+1} d_x s_x) + \sum_x^{64} (v^{x+1} w_x s_x) + \sum_x^{64} (v^{x+1} r_x s_x)]$$

and if x is less than 28, then $\frac{1}{2} \sum_{28}^{64} (v^{x+1} r_x s_x)$ must be substituted for the last term in the large bracket. This would involve the construction of a new set of tables, to avoid which (especially as these adjustments, as will be seen later, are of very little practical importance), I propose to use the approximation $\frac{1}{2} ({}^dM_x^s + {}^wM_x^s + {}^rM_x^s)$, with the substitution of ${}^rM_{28}^s$ for the last term when x is less than 28. The approximate value will be less than the correct value, since

$${}^dM_x^s = C_x s_x + C_{x+1} s_x + C_{x+2} s_x + \dots + C_{64} s_x,$$

whereas $\sum_x^{64} (v^{x+1} d_x s_x) = C_x s_x + C_{x+1} s_{x+1} + C_{x+2} s_{x+2} + \dots + C_{64} s_{64}$.

Probably $\cdot 7 ({}^dM_x^s + {}^wM_x^s + {}^rM_x^s)$ would be a closer approximation. In the second place, we have assumed that the year's contributions are invested at the end of the year, instead of during the year. It is customary to assume that they are all invested on the average in the middle of the year, in which case all our values will have to be multiplied by $(1 + \frac{1}{2}i)$. It is, I think, more reasonable to assume that one quarter of the yearly contributions will be invested quarterly, in which case the discount would be for $\frac{1}{4}v^1 + \frac{1}{4}v^2 + \frac{1}{4}v^3 + \frac{1}{4}v$, or, approximately, $\frac{5}{8}$ ths of a year, in which case we should have to multiply the values on the payment side by $(1 + \frac{5}{8}i)$. It sometimes happens, when the men pay one-half and the firm the other half of the contributions, that the men's share is paid monthly and the firm pay yearly, in which case the discount will be for $\frac{1}{8}v^1 + \frac{1}{8}v^2 + \frac{1}{8}v^3 + \frac{5}{8}v = \cdot 8$ of a year, approximately, and then the values on the payment side will have to be multiplied by $(1 + \cdot 2i)$. I may be told that dividends are generally paid half-yearly instead of yearly; but on the other hand no allowance is made for income tax.

The corrected value for Problem IVB will therefore be

$$X = (1 + \frac{5}{8}i) \left\{ \frac{\cdot 05 \sum_x^{64} s_x - \cdot 025 ({}^dM_x^s + {}^wM_x^s + {}^rM_x^s)}{\sum_x s_x (N_{65} + \frac{1}{2} D_{65})} \right\}$$

Then, with regard to the payments and benefits in Problem VI_B. Here, although we have assumed that the contributions will be paid up to the end of the year of exit, we have, on the other hand, returned all the contributions up to the end of that year; consequently, whatever correction we put on one side of the equation, we should have to put exactly the same on the other side, and our corrected formula will therefore be

$$X = (1 + \frac{3}{8}i) \left\{ \frac{.05(N_x^s - {}^dR_x^s - {}^wR_x^s - {}^rR_x^s)}{\sum s_x (N_{65} + \frac{1}{2}D_{65})} \right\}$$

This explanation will, I think, suffice to show how adjustments have to be made.

Problem VII_B.—What correction must be made in the annuity ascertained by Problems IV_B and VI_B, to provide for the return of the difference between the total contributions and annuity payments when death occurs before the latter amount to the former?

This is a condition which only affects the annuity immediately it is entered upon, and must be considered with reference only to the relation of the total contributions to the annuity, that is with relation of $P \cdot \frac{\sum s_x}{s_x}$ to $X \cdot \frac{\sum s_x}{s_x}$. Or the relation of P to X , where P in our particular case is $.05$.

We know X , the annuity, and P , the premium, and our object is to find a new X which we will call X' , which, with the value of an assurance commencing with P and decreasing by X' will be equal in value to X . The time it will take for X' to equal P , is evidently $\frac{P}{X'}$.

Following the same reasoning as in Problem I in the *Transactions of the Second Actuarial Congress*, we have

$$X'N_x + P(M_x - M_{x+\frac{P}{X'}+1}) - X'(R_{x+1} - R_{x+\frac{P}{X'}+1} - \frac{P}{X'} \cdot M_{x+\frac{P}{X'}+1}) = XN_x.$$

$$X'(N_x - R_{x+1} + R_{x+\frac{P}{X'}+1}) = XN_x - PM_x$$

$$X' = \frac{XN_x - PM_x}{N_x - R_{x+1} + R_{x+\frac{P}{X'}+1}}$$

and, substituting 65 for x and $.05$ for P , we have

$$X' = \frac{XN_{65} - .05M_{65}}{N_{65} - R_{66} + R_{66+\frac{.05}{X'}}$$

from which X' must be found by trial.

Problem VIII_B.—To ascertain the present value, at age at entrance x , of the return at death, before 65, of the total salary

accumulated at compound interest at the same rate as used in the valuation, equated to 1 of salary at entry.

The same reasoning as used in Problem IIA will apply to this Problem, for the accumulations from age x to age $x+n$ will be

$$s_x(1+i)^{n-1} + s_{x+1}(1+i)^{n-2} + \dots + s_{x+n-1}$$

and the present value will be found by multiplying by v^n , which will give

$$s_x v + s_{x+1} v^2 + s_{x+2} v^3 + \dots + s_{x+n-1} v^n$$

the sum of which we will call $(as)_n$.

So that in respect of l_x persons living at age x , the present value of the salaries to the end of the year of death accumulated at compound interest will be

$$(as)_1 d_x = v s_x d_x$$

$$(as)_2 d_{x+1} = v s_x d_{x+1} + v^2 s_{x+1} d_{x+1}$$

$$(as)_3 d_{x+2} = v s_x d_{x+2} + v^2 s_{x+1} d_{x+2} + v^3 s_{x+2} d_{x+2}$$

$$\vdots \quad \quad \quad \vdots \quad \quad \quad \vdots \quad \quad \quad \vdots$$

$$\Sigma = v s_x l'_x + v^2 s_{x+1} l'_{x+1} + v^3 s_{x+2} l'_{x+2} + \dots$$

The value at age x will therefore be

$$\frac{1}{l_x} (v s_x l'_x + v^2 s_{x+1} l'_{x+1} + v^3 s_{x+2} l'_{x+2} + \dots)$$

and equating this to a denominator of D_x^s , we have

$$\frac{1}{v^x s_x l_x} (v^{x+1} s_x l'_x + v^{x+2} s_{x+1} l'_{x+1} + v^{x+3} s_{x+2} l'_{x+2} + \dots)$$

By first forming a column of $v^{x+1} l'_x = v \cdot D'_x = {}^d D_x$, which has already been done, then multiplying each value of $v^{x+1} l'_x$ by s_x , forming a column which we will call ${}^d D_x^s$, and summing these again like the \mathbb{N} column and calling the values ${}^d \mathbb{N}_x^s$, we have the value of the return at death of total salaries equated to 1 at age x accumulated at compound interest

$$\frac{{}^d \mathbb{N}_x^s}{D_x^s}.$$

If there is to be an interval, say 5 years, before any return is to be granted, the value at age at entrance x will be

$$\frac{1}{l_x} [\{(1+i)^5 s_x + (1+i)^4 s_{x+1} + (1+i)^3 s_{x+2} + (1+i)^2 s_{x+3} + (1+i) s_{x+4} + s_{x+5}\} v^6 l'_{x+5} + v^7 s_{x+6} l'_{x+6} + \dots]$$

And equating to D_x^s we have

$$\frac{1}{v^x s_x v^x} [(1+i)^5 s_x + (1+i)^4 s_{x+1} + (1+i)^3 s_{x+2} + (1+i)^2 s_{x+3} \\ + (1+i) s_{x+4} + s_{x+5}] v^{x+6} l'_{x+5} + v^{x+7} s_{x+6} l'_{x+6} + \dots]$$

so that if we call the accumulations of s for n years $(as)_n$, the value of the benefit to commence after 5 years will be

$$\frac{(as)_{6.5} D_{x+5} + \frac{d}{1+i} s_{x+6}}{D_x^s}$$

And, generally, if there is an interval of n years before the benefit commences or can arise, the formula will be

$$(as)_{n+1} \frac{d}{1+i} D_{x+n} + \frac{d}{1+i} s_{x+n+1}}{D_x^s}$$

Problem IXB.—To construct a table for finding the amount of the accumulations of s from any age and for any term.

The amount of the accumulations for n years will be

$$(v^x s_x + v^{x+1} s_{x+1} + \dots + v^{x+n-1} s_{x+n-1}) (1+i)^{x+n-1}$$

so that by summing the values of $v^x s_x$ and calling the resulting column $\Sigma v^x s_x$, and placing the value of $(1+i)^{x-1}$ in the adjoining column, we shall be able to find the amount of the accumulations from the formula

$$(as)_n = (\Sigma v^x s_x - \Sigma v^{x+n} s_{x+n}) (1+i)^{x+n-1}$$

Problem XB.—To find the present value, at age x at entrance, of an annuity of total salary on retirement before 65, equated to salary of 1 at x .

Out of l_x persons entering at the age x ,

r_x would receive an annuity of s_x

r_{x+1} „ „ „ $s_x + s_{x+1}$

r_{x+2} „ „ „ $s_x + s_{x+1} + s_{x+2}$

\vdots

\vdots

\vdots

and calling a'_{x+1} the present value of an annuity of 1 to date from the end of the year x , the present value of all the annuities of total salaries would be

$$(r_x a'_{x+1}) s_x v + (r_{x+1} a'_{x+2}) (s_x + s_{x+1}) v^2 + (r_{x+2} a'_{x+3}) (s_x + s_{x+1} + s_{x+2}) v^3 + \dots$$

and equating to a denominator of D_x^s we have the present value of all the annuities equated to 1 of salary at age at entrance x

$$\frac{1}{l_x s_x v^x} \{ (r_x a'_{x+1}) s_x v^{x+1} + (r_{x+1} a'_{x+2}) (s_x + s_{x+1}) v^{x+2} + \dots \}$$

Taking the values inside the large bracket, and separating the symbols, we have

$$(r_x a'_{x+1}) s_x v^{x+1} = r_x v^{x+1} \cdot a'_{x+1} s_x$$

$$(r_{x+1} a'_{x+2}) (s_x + s_{x+1}) v^{x+2} = r_{x+1} v^{x+2} a'_{x+2} s_x + r_{x+1} v^{x+2} a'_{x+2} s_{x+1}$$

$$\begin{aligned} \text{third term} &= r_{x+2} v^{x+3} a'_{x+3} s_x + r_{x+2} v^{x+3} a'_{x+3} s_{x+1} \\ &\quad + r_{x+2} v^{x+3} a'_{x+3} s_{x+2} \\ &\quad \vdots \quad \quad \quad \vdots \quad \quad \quad \vdots \end{aligned}$$

Here s_x is common to the first column, s_{x+1} to the second column, and so on: hence we want first a summation of the values $r_x v^{x+1} a'_{x+1}$, which has already been done (see Problem IIIA), and the resulting column called ${}^{ra}M_x$. If now we multiply each value of ${}^{ra}M_x$ by s_x and call the result ${}^{ra}M_x^s$, and sum this column like the R column and call the new column ${}^{ra}R_x^s$, we shall have the present value of the benefit

$$= \frac{{}^{ra}R_x^s}{D_x^s}$$

If there is an interval before the first retirement takes place, or before the benefit is allowed, say n years, then the value of the benefit will be

$$\frac{(s_x + s_{x+1} + \dots + s_{x+n-1}) {}^{ra}M_{x+n} + {}^{ra}R_{x+n}^s}{D_x^s}$$

$$\text{or} \quad \frac{(s_x + s_{x+1} + \dots + s_{x+n}) {}^{ra}M_{x+n} + {}^{ra}R_{x+n+1}^s}{D_x^s}$$

There is one further Problem to solve before we have finished with the construction of our Tables, namely,

Problem XI B.—To find the present value, at age x at entrance, of an annuity on early retirement, based on last salary and number of years service, equated to 1 of salary at entrance.

Here, out of l_x persons entering at age x ,

$$\begin{array}{lll} r_x & \text{will receive an annuity of} & s_x \\ r_{x+1} & \text{,,} & 2s_{x+1} \\ r_{x+2} & \text{,,} & 3s_{x+2} \\ \vdots & & \vdots \end{array}$$

and equating, as before, the values of the annuities to a denominator of D_x^s , we have the present value

$$= \frac{1}{l_x s_x v^x} \{ (r_x a'_{x+1} s_x) v^{x+1} + 2(r_{x+1} a'_{x+2} s_{x+1}) v^{x+2} + 3(r_{x+2} a'_{x+3} s_{x+2}) v^{x+3} + \dots \}$$

separating symbols, we have for the value inside the large bracket

$$\begin{aligned}
 (r_x a'_{x+1s_x}) v^{x+1} &= r_x v^{x+1} a'_{x+1s_x} \\
 2(r_{x+1} a'_{x+2s_{x+1}}) v^{x+2} &= r_{x+1} v^{x+2} a'_{x+2s_{x+1}} + r_{x+1} v^{x+2} a'_{x+2s_{x+1}} \\
 3(r_{x+2} a'_{x+3s_{x+2}}) v^{x+3} &= r_{x+2} v^{x+3} a'_{x+3s_{x+2}} + r_{x+2} v^{x+3} a_{x+3s_{x+2}} \\
 &\quad + r_{x+2} v^{x+3} a_{x+3s_{x+2}} \\
 &\quad \vdots \qquad \qquad \qquad \vdots \qquad \qquad \qquad \vdots \qquad \qquad \qquad \vdots
 \end{aligned}$$

Now the values of $r_x v^{x+1} a'_{x+1}$ have already been calculated, and if we multiply each of these values by s_x we shall have the values of the terms in the series in the above columns. Summing these values we shall have the totals of each column. The values in this column we will call ${}^{ra}M_x^{ts}$. Summing these values again, the result of which we will call ${}^{ra}R_x^{ts}$, we shall have the value of the benefit equated to 1 of salary at age at entrance

$$= \frac{{}^{ra}R_x^{ts}}{D_x^s}.$$

If the benefit does not come into operation for a certain number of years, say n , the value will be

$$\frac{n \cdot {}^{ra}M_{x+n}^{ts} + {}^{ra}R_{x+n}^{ts}}{D_x^s}$$

The plan of basing the pension on the last annual salary received is not one to be recommended in connection with these Funds; for when the pension is to come out of a fund, and not directly out of the employer's pocket, a man's salary is often suddenly raised before his retirement to enable him to retire on a substantial pension; and it is generally the highly-paid officials who are thus treated. This is sometimes mitigated by basing the pension on the average of the last three years' salary; but a much better plan would be to base it on the salary received three years before retirement.

With all the Tables we have now constructed, we have the means of solving most of the problems which these Funds present. I will, however, content myself with giving two formulas, which the student can work out at his leisure.

Problem XII B.—To find the proportion of annual salary which will provide an annuity at 65 of 2 per-cent of total salary, with the conditions that

- (i) On withdrawal after five years half the contributions (without interest) shall be returned. No return on withdrawal within five years.

- (ii) On death before pension age, all the contributions, with compound interest at the rate of discount used in the calculations, shall be paid to relatives.
- (iii) On retirement from ill-health before 65 and after 15 years' service, an annuity of 2 per-cent of total salary shall be given; with the further condition that on retirement within 15 years, the total contributions with compound interest shall be returned.
- (iv) If, after pension is entered upon, death occur before the annuity payments amount to the total contributions without interest, the balance shall be paid to relatives.

If we call the proportion of salary without the last condition P , we shall have on the payment side, the present value of $P = P \cdot \mathbb{N}_x^s$. On the benefit side we shall have the present value of the annuity $= .02 \Sigma s_x (N_{65} + \frac{1}{2} D_{65})$;

the value of condition (i) $= \frac{1}{2} P \{ (\Sigma s_x - \Sigma s_{x+5})^w M_{x+5} + {}^w R_{x+5}^s \}$

the value of condition (ii) $= P {}^d \mathbb{N}_x^s$

the value of condition (iii) $= .02 \{ (\Sigma s_x - \Sigma s_{x+15})^{r^a} M_{x+15} + {}^{r^a} R_{x+15}^s \}$
 $+ P ({}^r \mathbb{N}_x^s - {}^r \mathbb{N}_{x+15}^s - (as)_{15} {}^r D_{x+15})$.

The value of condition (iv) we must ascertain after P is found. We thus have the equation

$$P [\mathbb{N}_x^s - \frac{1}{2} \{ (\Sigma s_x - \Sigma s_{x+5})^w M_{x+5} + {}^w R_{x+5}^s \} - {}^d \mathbb{N}_x^s - ({}^r \mathbb{N}_x^s - {}^r \mathbb{N}_{x+15}^s - (as)_{15} {}^r D_{x+15})] = .02 [\Sigma s_x (N_{65} + \frac{1}{2} D_{65}) + (\Sigma s_x - \Sigma s_{x+15})^{r^a} M_{x+15} + {}^{r^a} R_{x+15}^s]$$

and

$$\frac{.02 [\Sigma s_x (N_{65} + \frac{1}{2} D_{65}) + (\Sigma s_x - \Sigma s_{x+15})^{r^a} M_{x+15} + {}^{r^a} R_{x+15}^s]}{\mathbb{N}_x^s - \frac{1}{2} \{ (\Sigma s_x - \Sigma s_{x+5})^w M_{x+5} + {}^w R_{x+5}^s \} - {}^d \mathbb{N}_x^s - ({}^r \mathbb{N}_x^s - {}^r \mathbb{N}_{x+15}^s - (as)_{15} {}^r D_{x+15})}$$

and then \mathbb{P} , the proportion of salary for providing, in addition to the above benefits, for the return of the balance of contributions, if the annuity payments do not amount to the contributions without interest, must be found by the formula on page 226.

To find the annuity which a certain fixed proportion of salary will provide, with all the above conditions, the above formula will be turned upside down, and we have, if we call the annuity, without the last condition, X ,

$$\frac{\mathbb{N}_x^s - \frac{1}{2} \{ (\Sigma s_x - \Sigma s_{x+5})^w M_{x+5} + {}^w R_{x+5}^s \} - {}^d \mathbb{N}_x^s - ({}^r \mathbb{N}_x^s - {}^r \mathbb{N}_{x+15}^s - (as)_{15} {}^r D_{x+15})}{\Sigma s_x (N_{65} + \frac{1}{2} D_{65}) + (\Sigma s_x - \Sigma s_{x+15})^{r^a} M_{x+15} + {}^{r^a} R_{x+15}^s}$$

and X' , the reduced annuity to provide for condition (iv) can be found by the formula on page 236, and the two values of P and X' should agree.

THE VALUATION.

When you undertake to make a Valuation of one of these Funds, you will have to ask for such information as will enable you to construct a Table of Experience like our Table 4, including a Table of Average Salaries, and all the necessary particulars required for the Valuation. It is no use being modest in your requirements, as it is better to have too much than too little information; and it is as well to be prepared for every possible change in the benefits. My experience is that the Rules are altered about once in every five years, and you will generally find that new benefits have been added without your being consulted at all in the matter.

To show how a Fund is to be valued, I have prepared the following imaginary particulars:—

Number of Members	Number of Years Service	Present Annual Salary each receiving now	Total Annual Salary for all Members in Col. 1	Total Past Salary received by all Members in Col. 1	Total Past Salary, with 4 per-cent Compound Interest
(1)	(2)	(3)	(4)	(5)	(6)
Present Age 20					
10	5	45	450	1,625	1,750
10	4	40	400	1,200	1,260
5	4	45	225	650	682
5	4	55	275	750	785
10	3	45	450	1,125	1,165
5	2	40	200	375	382
5	1	50	250	250	250
50	...	...	2,250	5,975	6,274
Present Age 30					
5	15	75	375	3,562	4,144
5	14	75	375	3,500	3,975
11	13	90	990	8,580	9,900
4	13	80	320	2,860	3,300
15	12	85	1,275	10,800	13,860
4	11	85	340	2,750	3,100
1	11	120	120	935	1,139
3	10	100	300	2,250	2,531
1	10	300	300	1,500	1,695
1	8	105	105	660	741
50	...	...	4,500	37,397	44,385

Number of Members	Number of Years Service	Present Annual Salary each receiving now	Total Annual Salary for all Members in Col. 1	Total Past Salary received by all Members in Col. 1	Total Past Salary, with 4 per-cent Compound Interest
(1)	(2)	(3)	(4)	(5)	(6)
Present Age 40					
4	25	100	400	6,000	8,496
3	24	95	285	4,320	5,958
4	23	120	480	6,900	9,750
6	22	115	690	9,900	13,050
3	20	125	375	5,100	6,553
2	19	100	200	2,755	3,480
1	18	120	120	1,530	1,997
1	17	250	250	2,975	3,675
1	10	450	450	3,250	3,740
25	...	...	3,250	42,730	56,699
Present Age 50					
5	35	120	600	12,250	21,700
5	33	125	625	12,787	21,500
3	30	100	300	6,525	10,440
1	29	135	135	2,755	4,275
1	20	1,000	1,000	13,000	16,900
15	...	...	2,660	47,317	74,815
Present Age 60					
3	45	110	420	10,800	22,800
2	42	150	300	7,980	16,310
1	40	330	330	7,600	14,744
6	...	...	1,050	26,380	53,884

I have not included any annuitants on the Fund, because it would only complicate the Valuation unnecessarily, and they are easily calculated.

In valuing this Fund, I propose to value the various benefits separately, so that we shall be able, the more easily, to see the effect of any combination of benefits.

I shall also value the various benefits in respect of past and future salaries separately, so that we may be able not only to value an existing Fund, but show how a new Fund is to be formed.

To avoid using large figures we will reduce everything to one per-cent of salary.

VALUATION SCHEDULE.

SECTION I Contribution				SECTION II Pension based on Average Salary						SECTION III Return of 1 per-cent of Total Salary, without Interest, on Withdrawal							
Present Age	Number of Members	One per-cent of Present Salary =Contributions	$\frac{M_s^x}{D_s^x}$	Present Value of Future Contributions (3)×(4)	$\sum \frac{R_s^x}{N_s}$	1% of Total Salaries from Present Time if all live to Age 65 (3)×(6)	Total Past Contri- butions of 1 per-cent of Salary (8)	$N_{65} + \frac{1}{2} D_{65}^x$	Present Value of Pension of 1% of Total Future Salary (7)×(9)	Present Value of Pension of 1% of Total Past Salary (8)×(9)	Present Value of Pension of 1% of Total Salary (10)+(11)	$\frac{R_s^x}{N_s}$	$\frac{D_s^x}{N_s}$	$\frac{M_s^x}{D_s^x}$	Present Value in Respect of Future Contributions (3)×(13)	Present Value in Respect of Past Contributions (8)×(14)	Total of last two Cols. (15)+(16)
20	50	22.50	24.521	551.72	137.66	3097.4	59.75	.193	597.80	11.53	609.33	3.905	.397	87.87	23.71	111.58	
30	50	45.00	19.745	888.53	61.44	2761.8	373.97	.487	1316.45	182.11	1528.56	1.455	.191	65.48	71.50	136.98	
40	25	32.50	15.407	500.73	34.23	1112.5	427.30	.957	1064.66	408.93	1473.59	.360	.073	11.69	31.07	42.76	
50	15	26.60	10.119	269.16	17.47	464.7	473.17	1.782	828.10	843.19	1671.29	.011	.006	.30	3.01	3.31	
60	6	10.50	3.884	40.78	5.19	54.5	263.80	3.806	217.12	1004.02	1221.14	...	...	...	...	...
Totals	146	137.10	...	2250.92	...	7493.9	1597.99	...	4054.43	2449.78	6504.21	...	...	165.34	129.29	294.63

VALUATION SCHEDULE—(continued).

Present Age	Number of	SECTION IV Return of 1 per-cent of Total Salary, without Interest, on Death before 65					SECTION V Return of 1 per-cent of Total Salary, without Interest, on Retirement before 65					SECTION VI Annuity of 1 per-cent of Total Salary on Retirement before 65				
		$d_p^s \frac{R_x^s}{D_x^s}$	$d_p^x \frac{M_x}{D_x}$	Present Value in respect of Future Contributions (3) × (18)	Present Value in respect of Past Contributions (8) × (19)	Total of last two Cols. (20) + (21)	R_x^s D_x^s	$\frac{R_x^s}{D_x^s}$	Present Value in respect of Future Contributions (3) × (23)	Present Value in respect of Past Contributions (8) × (24)	Total of last two Cols. (23) + (24)	R_x^s D_x^s	$\frac{R_x^s}{D_x^s}$	Present Value in respect of Future Contributions (3) × (28)	Present Value in respect of Past Contributions (8) × (29)	Total of last two Cols. (30) + (31)
(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)
20	50	3.845	.084	86.51	5.01	91.52	2.966	.030	66.72	1.80	68.52	24.946	.253	561.28	15.14	576.42
30	50	3.588	.140	161.46	52.23	213.69	3.181	.075	143.14	28.19	171.33	26.754	.636	1203.90	237.66	1441.56
40	25	2.968	.187	96.46	79.91	176.37	3.137	.136	101.93	58.22	160.15	26.318	1.158	855.34	494.68	1350.02
50	15	1.780	.206	47.35	97.57	144.92	2.409	.212	64.08	100.21	164.29	19.994	1.795	531.84	849.12	1380.96
60	6	.401	.136	4.24	35.97	40.21	.813	.250	8.54	65.93	74.47	6.510	2.032	68.36	536.12	604.48
Totals	146	...	...	390.02	270.69	666.71	...	...	381.41	254.35	638.76	...	...	3220.72	2132.72	5353.44

VALUATION SCHEDULE—(continued).

		SECTION VII Return of 1 per-cent of Total Salary, with 4 per-cent Compound Interest, on Death before 65						SECTION VIII Return of 1 per-cent of Total Salary, with 4 per-cent Compound Interest, on Retirement before 65				
Present Age	Number of Members	1 per-cent of Total Past Salary, with 4 per-cent Compound Interest	$\frac{dY_x}{D_x}$	$\frac{dD_x}{D_x}$	Present Value in Respect of Future Contributions $(3) \times (34)$	Present Value in Respect of Past Contributions $(33) \times (33)$	Total of last two Cols. $(36) + (37)$	$\frac{dY_x}{D_x}$	$\frac{dD_x}{D_x}$	Present Value in Respect of Future Contributions $(3) \times (39)$	Present Value in Respect of Past Contributions $(33) \times (40)$	Total of last two Cols. $(41) + (42)$
(1)	(2)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)
20	50	62.74	6.704	.201	150.85	12.60	163.45	5.819	.124	131.61	7.78	139.39
30	50	443.85	5.627	.286	201.15	126.81	327.96	5.464	.212	245.88	93.95	339.83
40	25	566.99	4.086	.303	132.78	175.10	307.88	4.585	.271	148.99	153.76	302.75
50	15	748.15	2.139	.274	56.89	204.91	261.80	2.982	.306	79.33	228.73	308.06
60	6	538.84	.425	.146	4.46	78.81	83.27	.858	.272	9.01	146.62	155.63
Totals	146	2360.57	...	...	546.13	598.23	1144.36	...	...	614.82	630.84	1245.66

VALUATION SCHEDULE—(continued).

		SECTION IX Pension based on Last Salary																			
Present Age	Members.	(1)	(2)	(44)	(45)	1 per-cent of Present Salary × Number of Future Years to Age 65	1 per-cent of Total Present Salaries × Number of Years of Service, if all live to Age 65	(41) + (45)	$\frac{x_6}{x_x}$	(47)	(48)	1 per-cent of Last Salary × Number of Years of Past Service	(41) × (47)	1 per-cent of Last Salary × Number of Years of Total Service to Age 65	(49)	(50)	$N_{65} + \frac{1}{2}D_{65}$	Present Value of Pension in respect of Past Service	(52)	(53)	Present Value of 1 per-cent of Total Last Salaries in respect of Total Service (52) + (53)
20	50		78.50	1012.50	1091.00	5.022	394.23	5081.78	5479.01	.193	76.09	981.36	1057.45								
30	50		551.05	1575.00	2126.05	2.511	1383.69	3951.83	5338.52	.487	673.86	1926.00	2530.86								
40	25		652.70	812.50	1465.20	1.738	1134.39	1412.13	2546.52	.957	1085.61	1351.41	2437.02								
50	15		745.40	399.00	1144.40	1.329	990.64	530.28	1520.92	1.782	1765.32	944.96	2710.28								
60	6		447.00	52.50	499.50	1.076	480.97	56.51	537.48	3.806	1830.57	215.08	2045.65								
Totals	146		2474.65	3851.50	6326.15	...	4383.92	11038.53	15422.45	...	5431.45	5418.81	10850.26								

VALUATION SCHEDULE—(continued).

		SECTION X Annuity of 1 per-cent of last Salary and Number of Years of Service, on Retirement before 65						SECTION XI—Adjustments				
Present Age	Members of	$\frac{P}{D} R_{\frac{1}{2}}$	$\frac{M}{D} R_{\frac{1}{2}}$	Present Value in respect of Future Service (3) × (23)	Present Value in respect of Past Service (4) × (50)	Present Value in respect of Total Service (3) + (58)	$\frac{M}{D} R_{\frac{1}{2}}$	(3) × (60)	$d M_{\frac{1}{2}}$	(3) × (62)	$r M_{\frac{1}{2}}$	(3) × (64)
(1)	(2)	(55)	(56)	(57)	(58)	(59)	(60)	(61)	(62)	(63)	(64)	(65)
20	50	39.959	.253	899.08	19.89	918.97	.199	4.48	.042	.95	.015	.34
30	50	36.956	.636	1663.00	350.20	2013.20	.096	4.32	.070	3.15	.038	1.71
40	25	32.269	1.158	1048.50	755.63	1804.13	.037	1.20	.091	3.06	.068	2.21
50	15	22.204	1.795	590.64	1337.60	1928.24	.003	.08	.103	2.74	.106	2.82
60	6	6.675	2.032	700.9	908.45	978.51	...	...	.068	.71	.125	1.31
Totals	146	...	...	4271.31	3371.77	7643.08	...	10.08	...	10.61	...	8.39

I think there are only two explanations required with regard to the figures in this Schedule, beyond what are to be found in the former part of this paper. The first is with regard to the values in cols. (14), (19), (24), &c. These are the multipliers for valuing the benefits in respect of past contributions. The explanation will be better understood if we take the case of the return of contributions at death. (Section 4 of Valuation Schedule.) The Valuation in respect of future salary must be made with reference to the probable increase of salary, and therefore the Tables involving salary must be used; but with regard to past contributions, they are a known and ascertained quantity, and the value of the return of them in the event of death before 65 is the value of a temporary assurance of their amount, that is to say, we multiply by $\frac{M_x - M_{65}}{D_x} = \frac{{}^d M_{65}}{D_x}$. A similar argument applies to the corresponding columns in the other sections of the Valuation Schedule.

The other explanation has reference to columns (44) and (45). It may appear strange, but it is a fact, that the Valuation, when the pension is based on last received salary and number of years service, is more laborious than when the annuity is based on average salary and number of years service. When the basis is last salary, we have to make an estimate, in each individual case, of what his last salary will be, which is done by multiplying his present salary by $\frac{s_{64}}{s_x}$, and having done that we have to multiply the result by the number of years he will have served up to age 65. But, then, if an annuity is to be given on early retirement, based on last received salary, we require to know the amount of the liability if the present were the last salary. Consequently, we separate the number of years of service up to age 65 into past and future.

Take as an example, the particulars of those of the present age 50:—

No. of Members	No. of past years of service	Present salary of each Member	Total Salary receivable by all those of the same number of years' service	Salaries multiplied by past years of service Col. (4) × Col. (2)	Salaries multiplied by future years service
(1)	(2)	(3)	(4)	(5)	(6)
5	35	120	600	21,000	Here they have all got 15 years of service before 65, and it is only necessary to multiply the total £2,660 by 15
5	33	125	625	20,625	
3	30	100	300	9,000	
1	29	135	135	3,915	
1	20	1,000	1,000	20,000	
15	...	...	2,660	74,540	39,900

The sum of the last two columns, multiplied by $\frac{s_{64}}{s_{50}}$, will give the basis for pension at age 65.

In practice this portion of the work alone involves a great amount of labour.

Having prepared our Valuation Schedule, we will proceed to give a few examples of the pension which can be given, under different conditions, on the assumption that the contributions are 5 per-cent of salary, and that our Fund amounts to £12,000. Also, that there are no expenses, and that the interest on the Funds is 4 per-cent net, no deduction being made for income tax or anything else. Also, that the investments are made quarterly, so that our correction for over-discounting will be to increase the value by $\frac{3}{8}$ ths of 4 per-cent = $1\frac{1}{2}$ per-cent.

FUND I.

Pension as a
Percentage of *Average*
Salary for
every Year of Service

BENEFIT.

Pension on attainment of 65 only.

Present Value of 1 per-cent of Future Salaries 2250·92

Deduct:

Adjustment for $\frac{1}{2}$ year's Contributions on
withdrawal, death and early retirement,
over-estimated = 10·08 + 10·61 + 8·39 . 29·08

2221·84

Add: Adjustment for Over-discount ($1\frac{1}{2}$
per-cent) 33·33

2255·17
5

Present Value of Contributions of 5 per-cent
of Future Salaries 11275·85

Add: The Amount of the Fund 12000·00

Total Asset to provide Pensions 23275·85

This sum has to be divided by (6504·21) the Present
Value of Pensions of 1 per-cent of Total Salaries,
which will give
the Percentage of Average Salary for every Year of
Service.

3·579

3·512

N.B.—I have already given reasons (see p. 232) why this would
not be the proper rate for the Pension Benefit alone.

FUND II.

BENEFITS.

(i) *Pension on attainment of age 65.*

(ii) *Return of Contributions, without interest, on
death before 65.*

Present Value of 1 per-cent of Future Salaries 2250·92

Deduct:—

Adjustment for $\frac{1}{2}$ year's Contributions
on withdrawal and early retire-
ment, 10·08 + 8·39 18·47

Return of 1 per-cent of Total
Salary, without interest, on death 666·71

685·18

1565·74

Add: Adjustment for Over-Discount ($1\frac{1}{2}$
per-cent) 23·49

1589·23

5

Present Value of Contributions of 5 per-cent
of Future Salaries 7946·15

Add: Amount of Fund 12000·00

Total Asset to provide for Pension at 65 19946·15

This divided by 6504·21 will give

3·067

3·028

FUND III.		Pension as a Percentage of Average Salary for every Year of Service	
BENEFITS.		Without	With
(i) <i>Pension on attainment of age 65.</i>			
(ii) <i>Return of Contributions, without interest, on death before 65.</i>			
(iii) <i>Return of Contributions, without interest, on retirement before 65.</i>			
Present Value of 1 per-cent of Future Salaries	2250.92	Return of Difference between Total Contributions and Annuity Payments	
<i>Deduct:</i>			
Adjustment for $\frac{1}{2}$ year's Contributions on withdrawal	10.08		
Return of 1 per-cent of Total Salary, without interest, on death	666.71		
Return of 1 per-cent of Total Salary, without interest, on retirement	638.76		
	<u>1315.55</u>		
	935.37		
<i>Add:</i> Adjustment for Over-discount	14.03		
	<u>949.40</u>		
	5		
Present Value of Contributions of 5 per-cent of Salaries after providing for return on death and early retirement	4747.00		
<i>Add:</i> Amount of Fund	12000.00		
Total Asset to provide Pension	<u>16747.00</u>		
Which being divided by £6504.21 gives . . .	.	2.575	2.532

FUND IV.			
BENEFITS.			
(i) <i>Pension on attainment of age 65.</i>			
(ii) <i>Return of Contributions, without interest, on death before 65.</i>			
(iii) <i>Return of Contributions, without interest, on retirement before 65.</i>			
(iv) <i>Return of Contributions, without interest, on withdrawal.</i>			
Present Value of 1 per-cent of Future Salaries	2250.92		
<i>Deduct:</i>			
Return of 1 per-cent of Salaries on death	666.71		
Return of 1 per-cent of Salaries on retirement	638.76		
Return of 1 per-cent of Salaries on withdrawal	294.63		
	<u>1600.10</u>		
	650.82		
<i>Add:</i> Adjustment for Over-Discount	9.76		
	<u>660.58</u>		
	5		
Present Value of Contributions of 5 per-cent of Salaries after providing for return on death, early retirement and withdrawal . .	3302.90		
<i>Add:</i> Amount of Fund	12000.00		
Total Asset to provide Pension	<u>15302.90</u>		
Which being divided by 6504.21 gives . . . .	.	2.353	2.305

FUND V.		Pension as a Percentage of Average Salary for every year of Service	
BENEFITS:—		Without	With
(i) <i>Pension on attainment of age 65.</i>			
(ii) <i>Pension on retirement through ill-health before 65.</i>			
(iii) <i>Return of Contributions, without interest, on death before 65.</i>			
(iv) <i>Return of Contributions, without interest, on withdrawal.</i>			
Present Value of 1 per-cent of Future Salaries	2250·92	Return of Difference between Total Contributions and Annuity Payments	
<i>Deduct:—</i>			
Return of 1 per-cent of Salaries on death	666·71		
Return of 1 per-cent of Salaries on withdrawal	294·63		
	<u>961·34</u>		
	1289·58		
<i>Add: Adjustment for Over-discount</i>	19·34		
	<u>1308·92</u>		
	5		
Present Value of Contributions of 5 per-cent of Salaries after providing for return on death and withdrawal	6544·60		
<i>Add: Amount of Fund</i>	12000·00		
Total Asset to provide Pensions	<u>18544·60</u>		
This amount has to be divided by—			
Present Value of Pension of 1 per-cent of Total Salaries at age 65	6504·21		
Present Value of Pension of 1 per-cent of Total Salaries on retirement through ill-health before 65	5353·44		
	<u>11857·65</u>	1·564	1·502
N.B.—It is not necessary to make any adjustment in respect of the value of the liability for Pensions on early retirement: for although, by our assumptions, the Annuity is based upon half a year's more Salary than will be actually received, this is more than balanced by the Over-discounting and the fact that we have calculated the Annuity for Annual Payments.			

FUND VI.	
BENEFITS:—	
(i) <i>Pension on attainment of age 65.</i>	
(ii) <i>Pension on retirement through ill-health before 65.</i>	
(iii) <i>Return of Contributions, with interest, on death before 65.</i>	
(iv) <i>Return of Half Contributions, without interest, on withdrawal.</i>	
Present Value of 1 per-cent of Future Salaries	2250·92
<i>Deduct:—</i>	
1 per-cent of Salaries, with interest, on death	1141·36
$\frac{1}{2}$ per-cent of Salaries, without interest, on withdrawal	147·32
	<u>1391·68</u>
	859·24
<i>Add: Adjustment for Over-discount</i>	12·89
	<u>872·13</u>
	5
	4360·65
<i>Add: Amount of Fund</i>	12000·00
Total Asset to provide Pensions	<u>16360·65</u>
Dividing this as in Fund V by 11847·65 we have	

1·381

1·312

BENEFITS:—		FUND VII.		Pension as a Percentage of Last Salary for every Year of Service	
				Without	With
(i) Pension on attainment of age 65 based on last Salary.				Return of Difference between Total Contributions and Annuity Payments	
(ii) Return of Contributions, with interest, on retirement, before 65.					
(iii) Return of Contributions, without interest, on death before 65.					
(iv) Return of Half Contributions, without interest, on withdrawal.					
Present Value of 1 per-cent of Future Salaries	2250·92				
Deduct:					
1 per-cent of Salaries, with interest, on retirement .	1245·66				
1 per-cent of Salaries, without interest, on death .	666·71				
$\frac{1}{2}$ per-cent of Salaries, without interest, on withdrawal .	147·32				
	<u>2059·69</u>				
	191·23				
Add: Adjustment for Over-discount .	2·90				
	<u>194·13</u>				
	5				
	<u>970·65</u>				
Add: Fund .	12000·00				
Total Asset to provide Pension .	<u>12970·65</u>				
This has to be divided by 10,850·26, the Present Value of Pension of 1 per-cent of total last Salaries for total Years of Service = .				1·195	1·154

BENEFITS:—		FUND VIII.			
(i) Pension on attainment of age 65 based on last Salary.					
(ii) Pension on retirement before 65 based on last Salary.					
(iii) Return of Contributions, with interest, on death before 65.					
(iv) Return of Half Contributions, without interest, on withdrawal.					
Present Value of 1 per-cent of Future Salaries	2250·92				
Deduct:					
1 per-cent of Salaries, with interest, on death before 65 .	1144·36				
$\frac{1}{2}$ per-cent of Salaries, without interest, on withdrawal .	147·32				
	<u>1291·68</u>				
	959·24				
Add: Adjustment for Over-discount .	14·39				
	<u>973·63</u>				
	5				
	<u>4868·15</u>				
Add: Fund .	12000·00				
Total Asset to provide Pensions .	<u>16868·15</u>				
This has to be divided by—					
Present Value of Pension of 1 per-cent of last Salary on attainment of age 65 .	10850·26				
Present Value of Pension of 1 per-cent of last Salary on retirement before 65 .	7643·08				
	<u>18493·34</u>				
which will give a Pension of .				·912	·874

The values in the second column were found by the formula given on page 236 (Problem VII_B). For Funds I to VI inclusive, the relation of contributions to annuity is $S \cdot \frac{\sum s_x}{s_x} \cdot P$ to $S \cdot \frac{\sum s_x}{s_x} \cdot X$, that is, P to X , or 5 to the annuity-value in the first column. For Funds VII and VIII the relation is different, being, in fact, $S \cdot \frac{\sum s_x}{s_x} \cdot P$ to $S \cdot \frac{(65-x)s_{64}}{s_x} \cdot X$; that is, P to $\frac{S \cdot (65-x)s_{64}}{S \cdot \sum s_x} \cdot X$, or 5 to the annuity in the first column multiplied by $\frac{S \cdot (65-x)s_{64}}{S \cdot \sum s_x}$. Now, $S \cdot \frac{(65-x)s_{64}}{s_x}$ is 15,422.45 [see Valuation Schedule, column (50)], and $S \cdot \frac{\sum s_x}{s_x}$ is 9,092 (sum of columns (7) and (8) in Valuation Schedule); so that the multiplier will be $\frac{15,422.45}{9,092} = 1.696$. For Funds VII and VIII we must therefore substitute for P and X in the formula (Prob. VII_B) 5 and the annuity in the first column multiplied by 1.696 respectively. The value of X' , when found, must be divided by 1.696 to produce the value in the second column. It will nearly always be necessary to have columns (7) and (8) in the Valuation Schedule; but if they have not been calculated, then the multiplier of X must be found by assuming an average age at entrance, and using $\frac{(65-x)s_{64}}{\sum s_x}$. Thus, assuming 18 to be an average age at entrance, the multiplier will be $\frac{47 \cdot s_{64}}{\sum s_{18}} = 1.694$.

It sometimes happens that provisions are introduced which are supposed to produce enormous wealth. These I call excrescences, and they consist principally of the following:—(i) no return to be given to anyone leaving the service within five years; (ii) no annuity benefit to be granted for less than 10 years service; (iii) no annuity to exceed a certain figure, which, as a rule, only affects one or two of the most highly paid officials. Sometimes there is a provision (iv) that no annuity is to be less than a certain figure, which is a much more serious matter.

These can be dealt with in one of two ways; but anyhow they must first be carefully picked out. As to the deferred benefits you may value them directly by the formulas I have given for deferred benefits; or you may value the benefits as immediate, and afterwards deduct the value of the temporary assurance of the

benefits. The latter is preferable, as it shows at once how much the regulation is worth. The additions and deductions for the minimum and maximum pensions are a little more difficult, because you do not know whether they will be less or greater until you have ascertained what annuity the Fund will give, and then if there is much difference, the adjustment will affect the average annuity. Anyhow, you will have to pick out all the small salaries and see if the average annuity will give them the minimum pension, and if they do not, you must then increase the liability by the present value of a deferred annuity of the difference. Similarly you must take the higher salaries and pick out all those where the scale pension will exceed the maximum, and deduct from the liability the present value of a deferred annuity of the difference. The latter may not be quite correct, as you may be providing for more than the maximum annuity in the value of the pension on retirement from ill-health, but it is near enough.

In practice you will not be able to classify according to exact ages, and even if you could, you may be sure the salaries would not be increased on birthdays. Everything therefore has to be reduced to broad averages. The ages are generally given as current ages, which means age last birthday; and it will be most convenient to classify according to age (x) to ($x+1$). It will, under those circumstances, be near enough to use the mean of the values of the multipliers for ages x and $x+1$.

THE FORMATION OF A FUND.

I think it may be laid down as an axiom, that no one is able to form a Fund on safe lines until he knows how to value one. When you are asked to form a Fund, you must ask what the subscriptions are to be, and what benefits are to be given, and whether the employer is prepared to start the Fund with a substantial sum down, and whether he is prepared to guarantee a certain rate of interest. You will then ask for the same information that you would require for a valuation. You will then have to go through the whole process of constructing a Table of Multipliers according to the benefits.

If the employer is going to pay half the subscription, then the Fund will start with the minimum of benefits; that is to say:—

- (i) Pension, based on average salary, on the attainment of a certain age, say 65;
- (ii) Return of half the contributions, without interest, on withdrawal;

- (iii) Return of all contributions, without interest, on death ;
- (iv) Return of all contributions, without interest, on retirement through ill-health ;
- (v) The pension benefit to date back to entry on service.

Let us say that the contributions are to be 5 per-cent of salaries ; half to be paid by the employer and half by the employees.

Our first duty will be to ascertain what would be a reasonable pension. It would not be fair to the young men to make them subscribe for pensions to the old men, especially when the past years of service are to be taken into consideration ; nor would it be just that the employer should evade his responsibility by simply commencing to make a small annual subscription from the present time.

Suppose we fix upon the pension which the contributions from a member entering at age 20, at an average salary, would provide, as a fair average pension ; and let all things be the same as in our imaginary Fund :—

The Average Salary at age 20 is 45 ; 5 per-cent of which is 2·25. This, multiplied by $\frac{I_{20}^8}{D_{20}^8} (= 24·521)$ will give the value of the Future Contributions = 55·172

The Present Value of a return of half the Contributions, without interest on withdrawal, will be $1·125 \times \frac{R_{20}^8}{D_{20}^8} (= 1·125 \times 3·905)$ = 4·394

The Present Value of a return of all the Contributions, without interest, on death, will be 2·25 $\times \frac{dR_{20}^8}{D_{20}^8} (= 2·25 \times 3·845)$ = 8·651

The Present Value of a return of all the Contributions, without interest, on early retirement, will be 2·25 $\times \frac{rR_{20}^8}{D_{20}^8} (= 2·25 \times 2·966)$ = 6·672
19·717

Deducting the total of these Liabilities from the Present Value of the Future Contributions, there is left for Pension = 35·455

The Present Value of a Pension at 65 of 1 per-cent of Total Salary to age 65 is $·45 \times \frac{S_{20}}{s_{20}} \times \frac{N_{65} + \frac{1}{2}D_{65}}{D_{20}} (= ·45 \times 137·66 \times ·193)$. . . = 11·956

And the Pension in terms of a percentage of Average Salary for every Year of Service will be $35·455 \div 11·956 =$ 2·966

This seems very large, but it only amounts to 81 per-cent of the last salary for 45 years of service, or very little more on the average than $\frac{1}{6.0}$ th of last salary for every year of service.

The staff being supposed to be the same as given in the particulars on page 242, we proceed to make up the Valuation balance sheet as follows:—

Present Value of Pension of 2.966 per-cent of Average Salary for every Year of Service, past and future, = 2.966×6504.21 (see Section II. of Valuation Schedule)	= 19,291.48
Present Value of Return of Half Contributions, without interest, on withdrawal, = $\frac{1}{2}(165.34) \times 5$ (see Section III of Valuation Schedule)	= 413.35
Present Value of Return of Whole of Contributions, without interest, on death before 65, = 396.02×5 (see Section IV of Valuation Schedule)	= 1,980.10
Present Value of Return of Whole of Contributions, without interest, on retirement before 65, = 384.41×5 (see Section V of Valuation Schedule)	= 1,922.05
Total Liability	<u>23,606.98</u>
Present Value of Contributions of 5 per-cent of Salaries, = $2.250.92 \times 5$ (see Section I of Valuation Schedule)	= 11,254.60
The difference is the sum which the Employer ought to place down, in addition to his subscription of $2\frac{1}{2}$ per-cent of Salaries and guarantee of interest	<u>12,352.38</u>

The only alternative is to guarantee 4 per-cent of that amount in perpetuity, say roughly £500 a year.

Strange to say, although I have valued many of these Funds, and wound up a very large one, I have never formed one. I have been consulted often, but I have never found the employers willing to pay the price, and have all the annoyance and discontent which these Funds produce. On the other hand, I have nearly always persuaded them to guarantee a certain rate of pension on retirement from incapacity, based on years of service and average salary, which pension is to be understood to be a reward for faithful services, and to create their own Pension Fund. To find out how much should be set aside each year you only want Sections I, II and VI of the Valuation Schedule. I feel certain that if an employer wishes to retain the confidence and respect of his staff, the latter way is by far the best, and, in the long run, the most economical.

On closing this paper, which has extended far beyond the limits I intended, I wish to give a SPECIAL WARNING. *Tables based on any other rates of interest, or providing for superannuation at an age earlier than 65, would give totally different results; and*

it would be absolutely unsafe to assume that the results I have produced in the Valuation of my imaginary Fund would apply to any other Fund.

It nevertheless would be useful to have Tables of Multipliers for superannuation at other ages than 65, and at other rates of interest than 4 per-cent; and if any of the young Fellows are willing, by undertaking the work, to do a service to the Profession and the Institute, I shall be glad to help them, if they will place themselves in communication with me.

P.S.—I am glad to say that, in response to my invitation, a volunteer has come forward; and I therefore hope, in a short time, to be able to publish other Tables and Valuations which, when complete, will make this treatise a practical guide to the valuation of Staff Pension Funds, and to the effect upon the scale of pension which any alteration in the benefits will cause.

Hypothetical Experience of Staff Pension Fund.

TABLE 1.

Annual Rates of Mortality, Withdrawal and Retirement.

Age	MORTALITY		WITHDRAWAL	RETIREMENT	Age
	Normal	Modified to include Deaths after retirement			
(x)	(q_x)	(q_x)	(wq_x)	(rq_x)	(x)
15	·0036	·0036	·0750	...	15
16	·0037	·0037	·0892	...	16
17	·0038	·0038	·0910	...	17
18	·0039	·0039	·0838	...	18
19	·0010	·0010	·0761	...	19
20	·0011	·0011	·0698	...	20
21	·0042	·0012	·0630	...	21
22	·0043	·0013	·0571	...	22
23	·0044	·0014	·0518	...	23
24	·0045	·0015	·0472	...	24
25	·0016	·0016	·0431	...	25
26	·0018	·0018	·0396	...	26
27	·0019	·0019	·0361	...	27
28	·0050	·0050	·0335	·0002	28
29	·0052	·0052	·0309	·0003	29
30	·0054	·0054	·0285	·0004	30
31	·0056	·0057	·0261	·0005	31
32	·0058	·0059	·0243	·0006	32
33	·0060	·0061	·0226	·0007	33
34	·0062	·0064	·0209	·0008	34
35	·0064	·0067	·0195	·0009	35
36	·0067	·0069	·0180	·0010	36
37	·0070	·0074	·0166	·0012	37
38	·0073	·0078	·0154	·0014	38
39	·0076	·0081	·0143	·0016	39
40	·0080	·0087	·0132	·0018	40
41	·0084	·0090	·0121	·0020	41
42	·0089	·0098	·0112	·0022	42
43	·0094	·0102	·0101	·0024	43
44	·0100	·0110	·0092	·0028	44
45	·0107	·0118	·0082	·0032	45
46	·0114	·0126	·0072	·0037	46
47	·0122	·0133	·0062	·0042	47
48	·0130	·0144	·0053	·0048	48
49	·0139	·0156	·0043	·0055	49
50	·0148	·0165	·0033	·0063	50
51	·0157	·0175	·0024	·0073	51
52	·0168	·0187	·0014	·0085	52
53	·0180	·0200	·0005	·0099	53
54	·0193	·0216	...	·0115	54
55	·0209	·0233	...	·0135	55
56	·0225	·0254	...	·0159	56
57	·0243	·0273	...	·0190	57
58	·0262	·0296	...	·0235	58
59	·0285	·0318	...	·0304	59
60	·0310	·0346	...	·0397	60
61	·0338	·0372	...	·0545	61
62	·0369	·0401	...	·0720	62
63	·0402	·0431	...	·0870	63
64	·0437	·0453	...	·1015	64
65	·0471	·0471	...	1·0000	65

Hypothetical Experience of Staff Pension Fund.

TABLE 2.

Mortality Table (Modified q_x
allowing for Invalid Lives).

TABLE 3.

Combined Mortality and With-
drawal Table (Modified q_x).

Age	Living	Dying	Living and Re- main'g on Fund	Dying	Withdrawing	Age
x	$(l_x^{(2)})$	$d_x^{(2)}$	$(l_x^{(3)})$	$(d_x^{(3)})$	(w_x)	(x)
15	20,000	72	20,000	72	1,500	15
16	19,928	74	18,428	68	1,644	16
17	19,854	75	16,716	64	1,521	17
18	19,779	77	15,131	59	1,268	18
19	19,702	79	13,804	55	1,054	19
20	19,623	80	12,695	52	887	20
21	19,543	82	11,756	49	741	21
22	19,461	81	10,966	47	626	22
23	19,377	85	10,293	45	534	23
24	19,292	87	9,714	43	458	24
25	19,205	88	9,213	42	397	25
26	19,117	92	8,774	42	347	26
27	19,025	93	8,385	41	305	27
28	18,932	95	8,039	40	269	28
29	18,837	98	7,730	40	239	29
30	18,739	101	7,451	40	212	30
31	18,638	106	7,199	41	190	31
32	18,532	109	6,968	41	169	32
33	18,423	112	6,758	41	153	33
34	18,311	117	6,561	42	137	34
35	18,194	122	6,385	43	124	35
36	18,072	125	6,218	43	112	36
37	17,947	133	6,063	45	100	37
38	17,814	139	5,918	46	90	38
39	17,675	143	5,782	47	82	39
40	17,532	153	5,653	49	74	40
41	17,379	156	5,530	50	66	41
42	17,223	169	5,414	53	60	42
43	17,054	174	5,301	54	53	43
44	16,880	186	5,194	57	47	44
45	16,694	197	5,090	60	41	45
46	16,497	208	4,989	63	35	46
47	16,289	217	4,891	65	30	47
48	16,072	231	4,796	69	25	48
49	15,841	247	4,702	73	20	49
50	15,594	257	4,609	76	15	50
51	15,337	268	4,518	79	10	51
52	15,069	282	4,429	83	6	52
53	14,787	296	4,340	87	2	53
54	14,491	313	4,251	92	...	54
55	14,178	330	4,159	97	...	55
56	13,848	352	4,062	103	...	56
57	13,496	369	3,956	108	...	57
58	13,127	389	3,851	114	...	58
59	12,738	405	3,737	119	...	59
60	12,333	427	3,618	125	...	60
61	11,906	443	3,493	130	...	61
62	11,463	460	3,363	135	...	62
63	11,003	474	3,228	139	...	63
64	10,529	477	3,089	140	...	64
65	10,052	473	2,949	139	..	65

Hypothetical Experience of Staff Pension Fund.

TABLE 4.

Combined Mortality, Withdrawal and Retirement Table.
(Normal Death Rate).

Age	Living and Remaining on Active List	Dying	Withdrawing	Retiring	Total Decrements	Age
(<i>x</i>)	$l_x^{(4)}$	$d_x^{(4)}$	w_x	r_x	$(d_x^{(4)} + w_x + r_x)$	(<i>x</i>)
15	20,000	72	1,500	...	1,572	15
16	18,128	68	1,614	...	1,712	16
17	16,716	64	1,521	...	1,585	17
18	15,131	59	1,268	...	1,327	18
19	13,804	55	1,054	...	1,109	19
20	12,695	52	887	...	939	20
21	11,756	49	741	...	790	21
22	10,986	47	626	...	673	22
23	10,293	45	534	...	579	23
24	9,714	43	458	...	501	24
25	9,213	42	397	...	439	25
26	8,774	42	347	...	389	26
27	8,385	41	305	...	346	27
28	8,039	40	269	2	311	28
29	7,728	40	239	2	281	29
30	7,447	40	212	3	255	30
31	7,192	40	190	4	234	31
32	6,958	40	169	4	213	32
33	6,745	40	153	5	198	33
34	6,547	40	137	5	182	34
35	6,365	41	124	6	171	35
36	6,191	41	112	6	159	36
37	6,035	42	100	7	149	37
38	5,886	43	90	8	141	38
39	5,745	44	82	9	135	39
40	5,610	45	74	10	129	40
41	5,481	46	66	11	123	41
42	5,358	48	60	12	120	42
43	5,238	49	53	13	115	43
44	5,123	51	47	14	112	44
45	5,011	54	41	16	111	45
46	4,900	56	35	18	109	46
47	4,791	58	30	20	108	47
48	4,683	61	25	22	108	48
49	4,575	64	20	25	109	49
50	4,466	66	15	28	109	50
51	4,357	68	10	32	110	51
52	4,247	71	6	36	113	52
53	4,134	74	2	41	117	53
54	4,017	77	...	46	123	54
55	3,894	81	...	52	133	55
56	3,761	85	...	60	145	56
57	3,616	88	...	69	157	57
58	3,459	91	...	81	172	58
59	3,287	94	...	100	191	59
60	3,093	96	...	123	219	60
61	2,874	97	...	156	253	61
62	2,621	97	...	189	286	62
63	2,335	94	...	203	297	63
64	2,038	89	...	206	295	64
65	1,743	...	...	...	...	65

Hypothetical Experience of Staff Pension Fund.

TABLE 5.

Simple Commutation Columns (according to Table 2). 4 PER-CENT.

Age (x)	$D_x^{(2)}$	$N_x^{(1)}$	$C_x^{(2)}$	$M_x^{(2)}$	$R_x^{(2)}$	Age (x)
15	11,106	220,138	38.4	2,223.2	75,805.0	15
16	10,610	209,198	38.0	2,181.8	73,581.8	16
17	10,192	199,306	37.0	2,146.8	71,397.0	17
18	9,763	189,513	36.5	2,109.8	69,250.2	18
19	9,350	180,193	36.1	2,073.3	67,140.1	19
20	8,954	171,239	35.1	2,037.2	65,067.1	20
21	8,574	162,665	34.6	2,002.1	63,029.9	21
22	8,211	154,454	34.1	1,967.5	61,027.8	22
23	7,861	146,593	33.2	1,933.4	59,069.3	23
24	7,525	139,068	32.6	1,900.2	57,126.9	24
25	7,203	131,865	31.7	1,867.6	55,226.7	25
26	6,896	124,969	31.9	1,835.9	53,359.1	26
27	6,598	118,371	31.0	1,804.0	51,523.2	27
28	6,314	112,057	30.5	1,773.0	49,719.2	28
29	6,042	106,015	30.2	1,742.5	47,946.2	29
30	5,778	100,237	29.9	1,712.3	46,203.7	30
31	5,526	94,711	30.2	1,682.1	44,491.1	31
32	5,283	89,428	29.9	1,652.2	42,809.0	32
33	5,049	84,379	29.5	1,622.3	41,156.8	33
34	4,826	79,553	29.6	1,592.8	39,534.5	34
35	4,610	74,943	29.7	1,563.2	37,941.7	35
36	4,405	70,538	29.3	1,533.5	36,378.5	36
37	4,205	66,333	30.0	1,504.2	34,845.0	37
38	4,011	62,319	30.1	1,474.2	33,340.8	38
39	3,829	58,490	29.8	1,444.1	31,866.6	39
40	3,652	54,838	30.6	1,414.3	30,422.5	40
41	3,481	51,357	30.0	1,383.7	29,008.2	41
42	3,317	48,040	31.3	1,353.7	27,624.5	42
43	3,157	44,883	31.0	1,322.4	26,270.8	43
44	3,005	41,878	31.8	1,291.1	24,948.4	44
45	2,858	39,020	32.4	1,259.6	23,657.0	45
46	2,715	36,305	32.9	1,227.2	22,397.4	46
47	2,579	33,726	33.0	1,194.3	21,170.2	47
48	2,446	31,280	33.8	1,161.3	19,975.9	48
49	2,317	28,963	34.8	1,127.5	18,814.6	49
50	2,191	26,769	34.8	1,092.7	17,687.1	50
51	2,075	24,691	34.7	1,057.9	16,594.1	51
52	1,960	22,731	35.3	1,023.2	15,536.5	52
53	1,850	20,881	35.6	987.9	14,513.3	53
54	1,743	19,141	36.2	952.3	13,525.4	54
55	1,640	17,501	36.7	916.1	12,573.1	55
56	1,540	15,961	37.6	879.1	11,657.0	56
57	1,443	14,518	37.9	841.8	10,777.6	57
58	1,350	13,168	38.5	803.9	9,935.8	58
59	1,260	11,908	38.5	765.1	9,134.9	59
60	1,173	10,735	39.0	726.9	8,366.5	60
61	1,088	9,647	38.9	687.9	7,639.6	61
62	1,008	8,639	38.9	649.0	6,951.7	62
63	930	7,709	38.5	610.1	6,302.7	63
64	856	6,853	37.3	571.6	5,692.6	64
65 (	785					
(	$\times a_{65}$ Eng. Life)	= 6,068	35.5	534.3	5,121.0	65

Hypothetical Experience of Staff Pension Fund.

TABLE 6.

Simple Commutation Columns (according to Table 3). 4 PER-CENT.

Age (x)	$D_x^{(3)}$	$N_x^{(3)}$	$C_x^{(3)}$	$M_x^{(3)}$	$R_x^{(3)}$	Age (x)
15	11,106	105,143	38.4	818.9	23,667.8	15
16	9,841	95,602	34.9	810.5	22,818.9	16
17	8,582	87,020	31.6	775.6	22,008.4	17
18	7,469	79,551	28.0	741.0	21,232.8	18
19	6,551	73,000	25.1	716.0	20,488.8	19
20	5,794	67,206	22.8	690.9	19,772.8	20
21	5,159	62,017	20.7	668.1	19,081.9	21
22	4,628	57,419	19.1	647.4	18,413.8	22
23	4,175	53,214	17.6	628.3	17,766.4	23
24	3,790	49,454	16.1	610.7	17,138.1	24
25	3,455	45,999	15.1	594.6	16,527.4	25
26	3,164	42,835	14.6	579.5	15,932.8	26
27	2,908	39,927	13.7	564.9	15,353.3	27
28	2,681	37,246	12.8	551.2	14,788.4	28
29	2,480	34,766	12.3	538.4	14,237.2	29
30	2,297	32,469	11.9	526.1	13,698.8	30
31	2,134	30,335	11.7	514.2	13,172.7	31
32	1,987	28,348	11.2	502.5	12,658.5	32
33	1,853	26,495	10.8	491.3	12,156.0	33
34	1,729	24,766	10.6	480.5	11,664.7	34
35	1,618	23,148	10.5	469.9	11,184.2	35
36	1,516	21,632	10.1	459.4	10,714.3	36
37	1,421	20,211	10.1	449.3	10,254.9	37
38	1,333	18,878	10.0	439.2	9,805.6	38
39	1,253	17,625	9.8	429.2	9,366.4	39
40	1,178	16,447	9.8	419.4	8,937.2	40
41	1,108	15,339	9.6	409.6	8,517.8	41
42	1,043	14,296	9.8	400.0	8,108.2	42
43	982	13,314	9.6	390.2	7,708.2	43
44	925	12,389	9.8	380.6	7,318.0	44
45	872	11,517	9.9	370.8	6,937.4	45
46	822	10,695	10.0	360.9	6,566.6	46
47	774	9,921	9.9	350.9	6,205.7	47
48	730	9,191	10.1	341.0	5,854.8	48
49	688	8,503	10.3	330.9	5,513.8	49
50	648	7,855	10.3	320.6	5,182.9	50
51	612	7,243	10.3	310.3	4,862.3	51
52	577	6,666	10.4	300.0	4,552.0	52
53	543	6,123	10.5	289.6	4,252.0	53
54	511	5,612	10.6	279.1	3,962.4	54
55	482	5,130	10.8	268.5	3,683.3	55
56	451	4,679	11.0	257.7	3,414.8	56
57	424	4,255	11.1	246.7	3,157.1	57
58	396	3,859	11.3	235.6	2,910.4	58
59	370	3,489	11.3	224.3	2,674.8	59
60	344	3,145	11.4	213.0	2,450.5	60
61	319	2,826	11.4	201.6	2,237.5	61
62	295	2,531	11.4	190.2	2,035.9	62
63	272	2,259	11.3	178.8	1,845.7	63
64	251	2,008	10.9	167.5	1,666.9	64
65 {	230					
$\times a_{65} \text{ Eng. Life}$		1,778	10.4	156.6	1,499.4	65

Note.—The column $D_x^{(3)}$ was not formed direct from the corresponding l_x column ($l_x^{(3)}$), but by the addition to $D_x^{(1)}$ of a commutation column based on the survivors among the premature pensioners. This column was afterwards rejected, but $D_x^{(2)}$ was left unaltered as much of the subsequent work was then done. The figures therefore differ in some instances to the extent of 1 in the last place from what would have been obtained direct from $l_x^{(2)}$. Hence the slight discrepancies in the annuity-values (p. 214) for Tables 2 and 3, which at ages 55

Hypothetical Experience of Staff Pension Fund.

TABLE 7.

Simple Commutation Columns (according to Table 4). 4 PER-CENT.

Age (x)	$D_x^{(4)}$	$N_x^{(4)}$	$C_x^{(4)}$	$M_x^{(4)}$	$R_x^{(4)}$	Age (x)
15	11,106	103,801	38.4	736.1	17,918.8	15
16	9,811	93,960	34.9	697.7	17,182.7	16
17	8,582	85,378	31.6	662.8	16,485.0	17
18	7,469	77,909	28.0	631.2	15,822.2	18
19	6,551	71,358	25.1	603.2	15,191.0	19
20	5,794	65,564	22.8	578.1	14,587.8	20
21	5,159	60,105	20.7	555.3	14,009.7	21
22	4,628	55,777	19.1	534.6	13,454.4	22
23	4,175	51,602	17.6	515.5	12,919.8	23
24	3,790	47,812	16.1	497.9	12,404.3	24
25	3,455	44,357	15.1	481.8	11,906.4	25
26	3,164	41,193	14.6	466.7	11,424.6	26
27	2,908	38,285	13.7	452.1	10,957.9	27
28	2,681	35,604	12.8	438.4	10,505.8	28
29	2,479	33,125	12.3	425.6	10,067.4	29
30	2,296	30,829	11.9	413.3	9,641.8	30
31	2,132	28,697	11.4	401.4	9,228.5	31
32	1,984	26,713	11.0	390.0	8,827.1	32
33	1,849	24,861	10.5	379.0	8,437.1	33
34	1,725	23,139	10.1	368.5	8,058.1	34
35	1,613	21,526	10.0	358.4	7,689.6	35
36	1,510	20,016	9.6	348.4	7,331.2	36
37	1,414	18,602	9.5	338.8	6,982.8	37
38	1,326	17,276	9.3	329.3	6,644.0	38
39	1,245	16,031	9.2	320.0	6,314.7	39
40	1,169	14,862	9.0	310.8	5,994.7	40
41	1,098	13,761	8.9	301.8	5,683.9	41
42	1,032	12,732	8.9	292.9	5,382.1	42
43	970	11,762	8.7	284.0	5,089.2	43
44	912	10,850	8.7	275.3	4,805.2	44
45	858	9,992	8.9	266.6	4,529.9	45
46	807	9,185	8.9	257.7	4,263.3	46
47	758	8,427	8.8	248.8	4,005.6	47
48	713	7,714	8.9	240.0	3,756.8	48
49	669	7,015	9.0	231.1	3,516.8	49
50	628	6,417	8.9	222.1	3,285.7	50
51	590	5,827	8.8	213.2	3,063.6	51
52	553	5,274	8.9	204.4	2,850.4	52
53	517	4,757	8.9	195.5	2,646.0	53
54	483	4,274	8.9	186.6	2,450.5	54
55	451	3,823	9.0	177.7	2,263.9	55
56	418	3,405	9.1	168.7	2,086.2	56
57	387	3,018	9.0	159.6	1,917.5	57
58	356	2,662	9.0	150.6	1,757.9	58
59	325	2,337	8.9	141.6	1,607.3	59
60	291	2,043	8.8	132.7	1,465.7	60
61	263	1,780	8.5	123.9	1,333.0	61
62	230	1,550	8.2	115.4	1,209.1	62
63	197	1,353	7.6	107.2	1,093.7	63
64	166	1,187	7.0	99.6	986.5	64
65 { ($\times a_{65}$ Eng. Life)	136	1,051	6.2	92.6	886.9	65

Hypothetical Experience of Staff Pension Fund.

TABLE 8.

*Special Mortality Table for obtaining Values of Annuities
on the Lives of Invalid Pensioners.*

PENSION AGE 65.

INTEREST 4 PER-CENT.

x	$l_x^{(r)}$	$q_x^{(r)}$	$d_x^{(r)}$	$D_x^{(r)}$	$N_x^{(r)}$	a'_x	x
29	20,000	·1000	2,000	6,412	44,855	6·99	29
30	18,000	·0990	1,782	5,550	39,305	7·08	30
31	16,218	·0980	1,590	4,808	34,497	7·18	31
32	14,628	·0965	1,412	4,169	30,328	7·28	32
33	13,216	·0950	1,256	3,625	26,703	7·37	33
34	11,960	·0935	1,118	3,152	23,551	7·47	34
35	10,842	·0920	997	2,747	20,804	7·57	35
36	9,815	·0905	891	2,399	18,405	7·67	36
37	8,954	·0890	797	2,098	16,307	7·77	37
38	8,157	·0875	711	1,837	14,470	7·88	38
39	7,443	·0860	640	1,612	12,858	7·97	39
40	6,803	·0845	575	1,417	11,441	8·07	40
41	6,228	·0830	517	1,247	10,194	8·17	41
42	5,711	·0815	465	1,100	9,091	8·27	42
43	5,246	·0800	420	971	8,123	8·37	43
44	4,826	·0785	379	859	7,261	8·46	44
45	4,447	·0770	342	761	6,503	8·55	45
46	4,105	·0755	310	676	5,827	8·62	46
47	3,795	·0740	281	601	5,226	8·70	47
48	3,514	·0725	255	535	4,691	8·77	48
49	3,259	·0710	231	477	4,214	8·83	49
50	3,028	·0695	210	426	3,788	8·89	50
51	2,818	·0680	192	381	3,407	8·94	51
52	2,626	·0665	175	342	3,065	8·96	52
53	2,451	·0650	159	307	2,758	8·98	53
54	2,292	·0635	146	276	2,482	8·99	54
55	2,146	·0620	133	248	2,234	9·01	55
56	2,013	·0605	122	224	2,010	8·98	56
57	1,891	·0590	112	202	1,808	8·95	57
58	1,779	·0575	102	183	1,625	8·88	58
59	1,677	·0560	94	166	1,459	8·79	59
60	1,583	·0545	86	150	1,309	8·73	60
61	1,497	·0530	79	137	1,172	8·55	61
62	1,418	·0515	73	125	1,047	8·38	62
63	1,345	·0500	67	114	933	8·18	63
64	1,278	·0485	62	104	829	7·97	64
65	1,216	·0471	57	95	734	7·73	65

$\times(7\cdot73 a_{65} \text{ Eng.})$

NOTE.—The above columns are inserted for the sake of completeness, but (with the exception of the last) are not made use of. The symbols used must be distinguished from those given elsewhere in which the prefix (r) is used to denote functions based on r_x (the No. of invalid retirements at age x).

Hypothetical Experience of Staff Pension Fund.

TABLE 9.

*Commutation Columns for valuing Benefits on Death, Withdrawal,
or Early Retirement.*

PENSION AGE 65.

INTEREST 4 PER-CENT.

d_{C_x}	dM_x = $\sum_{x=64}^{x-1} C_x$	dR_x = $\sum_{x=64}^{x-1} M_x$	wC_x = ${}^wC_x \times v^{x-1}$	wM_x = $\sum_{x=64}^{x-1} {}^wC_x$	wR_x = $\sum_{x=64}^{x-1} {}^wM_x$	rC_x = ${}^rC_x \times v^{x-1}$	rM_x = $\sum_{x=64}^{x-1} {}^rC_x$	rR_x = $\sum_{x=64}^{x-1} {}^rM_x$	Age (x)
38.4	643.5	12101.9	801	5,779	35,719	...	174.35	7123.46	15
34.9	605.1	11758.4	841	4,978	29,910	...	174.35	6949.11	16
31.6	570.2	11153.3	751	4,134	21,962	...	174.35	6774.76	17
28.0	538.6	10583.1	602	3,383	20,828	...	174.35	6600.41	18
25.1	510.6	10044.5	481	2,781	17,145	...	174.35	6426.06	19
22.8	485.5	9533.9	389	2,300	14,664	...	174.35	6251.71	20
20.7	462.7	9048.4	313	1,911	12,364	...	174.35	6077.36	21
19.1	442.0	8585.7	254	1,598	10,153	...	174.35	5903.01	22
17.6	422.9	8143.7	208	1,344	8,855	...	174.35	5728.66	23
16.1	405.3	7720.8	172	1,136	7,511	...	174.35	5554.31	24
15.1	389.2	7315.5	143	964	6,375	...	174.35	5379.96	25
14.6	374.1	6926.3	120	821	5,411	...	174.35	5205.61	26
13.7	359.5	6552.2	102	701	4,590	...	174.35	5031.26	27
12.8	345.8	6192.7	86	599	3,889	.61	174.35	4856.91	28
12.3	333.0	5846.9	74	513	3,290	.62	173.71	4682.56	29
11.9	320.7	5513.9	63	439	2,777	.89	173.09	4508.85	30
11.4	308.8	5193.2	54	376	2,338	1.11	172.20	4335.76	31
11.0	297.4	4884.4	46	322	1,962	1.10	171.06	4163.56	32
10.5	286.4	4587.0	40	276	1,610	1.32	169.96	3992.50	33
10.1	275.9	4300.6	35	236	1,364	1.27	168.61	3822.54	34
10.0	265.8	4024.7	30	201	1,128	1.46	167.37	3653.90	35
9.6	255.8	3758.9	26	171	927	1.40	165.91	3486.53	36
9.5	246.2	3503.1	23	145	756	1.58	164.51	3320.62	37
9.3	236.7	3256.9	20	122	611	1.73	162.93	3156.11	38
9.2	227.4	3020.2	17	102	489	1.88	161.20	2993.18	39
9.0	218.2	2792.8	15	85	387	2.00	159.32	2831.98	40
8.9	209.2	2574.6	13	70	302	2.12	157.32	2672.66	41
8.9	200.3	2365.4	11	57	232	2.22	155.20	2515.34	42
8.7	191.4	2165.1	9	46	175	2.31	152.98	2360.14	43
8.7	182.7	1973.7	8	37	129	2.40	150.67	2207.16	44
8.9	174.0	1791.0	7	29	92	2.63	148.27	2056.49	45
8.9	165.1	1617.0	6	22	63	2.85	145.64	1908.22	46
8.8	156.2	1451.9	5	16	41	3.04	142.79	1762.58	47
8.9	147.4	1295.7	4	11	25	3.22	139.75	1619.79	48
9.0	138.5	1148.3	3	7	14	3.52	136.53	1480.04	49
8.9	129.5	1009.8	2	4	7	3.79	133.01	1343.51	50
8.8	120.6	880.3	1	2	3	4.16	129.22	1210.50	51
8.9	111.8	759.7	1	1	1	4.50	125.06	1081.28	52
8.9	102.9	647.9	...	...	...	4.93	120.56	956.22	53
8.9	94.0	545.0	...	...	...	5.32	115.63	835.66	54
9.0	85.1	451.0	...	...	...	5.78	110.31	720.03	55
9.1	76.1	365.9	...	...	...	6.41	104.53	609.72	56
9.0	67.0	289.8	...	...	...	7.09	98.12	505.19	57
9.0	58.0	222.8	...	...	...	8.01	91.03	407.07	58
8.9	49.0	164.8	...	...	...	9.51	83.02	316.04	59
8.8	40.1	115.8	...	...	...	11.24	73.51	233.02	60
8.5	31.3	75.7	...	...	...	13.71	62.27	159.51	61
8.2	22.8	44.4	...	...	...	15.97	48.56	97.24	62
7.6	14.6	21.6	...	...	...	16.50	32.59	48.68	63
7.0	7.0	7.0	...	...	...	16.09	16.09	16.09	64

NOTE.—The figures in old-faced type in column rM_x are repetitions of ${}^rM_{23}$, and in rR_x are the continuous summation of rM_x . The column rR_x can thus be used continuously for all ages to obtain the value of the return of contributions

Hypothetical Experience of Staff Pension Fund.

TABLE 10.

Table for valuing Return of Contributions WITH COMPOUND
INTEREST AT 4% per annum on Death or Early Retirement.
PENSION AGE 65. INTEREST 4 PER-CENT.

Age (x)	d_x^i	v_x^i $= \sum_{t=x}^{\infty} d_t^i$	d_x^i $= v_x^i \times v^{x+1}$	d_x^i $= \sum_{t=x}^{\infty} d_t^i$	v_x	Σv_x	$v_x D_x$ $= \Sigma v_x \times v^{x+1}$	$v_x \Pi_x$ $= \Sigma v_x D_x$	Age (x)
15	72	2,970	1,586	25,140	...	...	878	18,463	15
16	68	2,898	1,488	23,554	...	...	844	17,585	16
17	64	2,830	1,397	22,066	...	...	811	16,741	17
18	59	2,766	1,313	20,669	...	...	780	15,930	18
19	55	2,707	1,235	19,356	...	...	750	15,150	19
20	52	2,652	1,164	18,121	...	...	721	14,400	20
21	49	2,600	1,097	16,957	...	...	693	13,679	21
22	47	2,551	1,035	15,860	...	...	667	12,986	22
23	45	2,501	977	14,825	...	...	641	12,319	23
24	43	2,459	922	13,848	...	...	617	11,678	24
25	42	2,416	871	12,926	...	...	593	11,061	25
26	42	2,374	823	12,055	...	...	570	10,468	26
27	41	2,332	778	11,232	...	...	548	9,898	27
28	40	2,291	735	10,451	2	1,611	527	9,350	28
29	40	2,251	694	9,719	2	1,612	506	8,823	29
30	40	2,211	656	9,025	3	1,610	486	8,317	30
31	40	2,171	619	8,369	4	1,637	467	7,831	31
32	40	2,131	584	7,750	4	1,633	448	7,364	32
33	40	2,091	551	7,166	5	1,629	429	6,916	33
34	40	2,051	520	6,615	5	1,624	412	6,487	34
35	41	2,011	490	6,095	6	1,619	395	6,075	35
36	41	1,970	462	5,605	6	1,613	378	5,680	36
37	42	1,929	435	5,143	7	1,607	362	5,302	37
38	43	1,887	409	4,708	8	1,600	347	4,940	38
39	44	1,844	384	4,299	9	1,592	332	4,593	39
40	45	1,800	361	3,915	10	1,583	317	4,261	40
41	46	1,755	338	3,554	11	1,573	303	3,944	41
42	48	1,709	316	3,216	12	1,562	289	3,641	42
43	49	1,661	296	2,900	13	1,550	276	3,352	43
44	51	1,612	276	2,604	14	1,537	263	3,076	44
45	54	1,561	257	2,328	16	1,523	251	2,813	45
46	56	1,507	239	2,071	18	1,507	239	2,562	46
47	58	1,451	221	1,832	20	1,489	227	2,323	47
48	61	1,393	204	1,611	22	1,469	215	2,096	48
49	64	1,332	187	1,407	25	1,447	204	1,881	49
50	66	1,268	172	1,220	28	1,422	192	1,677	50
51	68	1,202	156	1,048	32	1,391	181	1,485	51
52	71	1,134	142	892	36	1,362	170	1,304	52
53	74	1,063	128	750	41	1,326	160	1,134	53
54	77	989	111	622	46	1,285	149	974	54
55	81	912	101	508	52	1,239	138	825	55
56	85	831	89	407	60	1,187	127	687	56
57	88	746	77	318	69	1,127	116	560	57
58	91	658	65	241	81	1,058	105	444	58
59	94	567	54	176	100	977	93	339	59
60	96	472	43	122	123	877	80	246	60
61	97	377	33	79	156	754	66	166	61
62	97	280	24	46	189	598	51	100	62
63	94	183	15	22	203	409	33	49	63
64	89	89	7	7	206	206	16	16	64

NOTE.—The figures in old-faced type in column vD_x are the values of $\{ {}^vD_{25} \times (1+i)^{(25-x)} \}$, and in column ${}^v\Pi_x$ are the continuous summation of vD_x .

Hypothetical Experience of Staff Pension Fund.

TABLE 11.

Table for finding the Value of a Pension of 1 for each Year of Service, on Early Retirement.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	rC_x	a'_{x+1}	${}^{ra}C_x$ $= {}^rC_x \times a'_{x+1}$	${}^{ra}M_x$ $= \sum {}^{ra}C_x$	${}^{ra}R_x$ $= \sum {}^{ra}M_x$	Age (x)
28	·64	6·99	4·47	1467·95	40935·39	28
29	·62	7·08	4·39	1463·48	39167·44	29
30	·89	7·18	6·39	1459·09	38003·96	30
31	1·14	7·28	8·30	1452·70	36511·87	31
32	1·10	7·37	8·11	1444·40	35092·17	32
33	1·32	7·47	9·86	1436·29	33647·77	33
34	1·27	7·57	9·61	1426·43	32211·48	34
35	1·46	7·67	11·20	1416·82	30785·05	35
36	1·40	7·77	10·88	1405·62	29368·23	36
37	1·58	7·88	12·45	1394·74	27962·61	37
38	1·73	7·97	13·79	1382·29	26567·87	38
39	1·88	8·07	15·17	1368·50	25185·58	39
40	2·00	8·17	16·34	1353·33	23817·08	40
41	2·12	8·27	17·53	1336·99	22463·75	41
42	2·22	8·37	18·58	1319·46	21126·76	42
43	2·31	8·46	19·51	1300·88	19807·30	43
44	2·40	8·55	20·52	1281·34	18506·42	44
45	2·63	8·62	22·67	1260·82	17225·08	45
46	2·85	8·70	24·80	1238·15	15961·26	46
47	3·04	8·77	26·66	1213·35	14726·11	47
48	3·22	8·83	28·43	1186·69	13512·76	48
49	3·52	8·89	31·29	1158·26	12326·07	49
50	3·79	8·94	33·88	1126·97	11167·81	50
51	4·16	8·96	37·27	1093·09	10040·84	51
52	4·50	8·98	40·41	1055·82	8947·75	52
53	4·93	8·99	44·32	1015·41	7891·93	53
54	5·32	9·01	47·93	971·09	6876·52	54
55	5·78	8·98	51·90	923·16	5905·43	55
56	6·41	8·95	57·37	871·26	4982·27	56
57	7·09	8·88	62·96	813·89	4111·01	57
58	8·01	8·79	70·41	750·93	3297·12	58
59	9·51	8·73	83·02	680·52	2516·19	59
60	11·24	8·55	96·10	597·50	1865·67	60
61	13·71	8·38	114·89	501·40	1268·17	61
62	15·97	8·18	130·63	386·51	766·77	62
63	16·50	7·97	131·50	255·88	380·26	63
64	16·09	7·73	124·38	124·38	124·38	64
65	130·90	...	...	...	..	65

Hypothetical Experience of Staff Pension Fund.

TABLE 12.

Table of Average Salaries and various combinations thereof.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	s_x	Σs_x	Σs_x : s_x	s_{64} $\div s_x$	$s_x v^x$	$\Sigma s_x v^x$	$(1+i)^{x-1}$	Age (x)
15	20	6,345	317.25	11.300	11.11	1179.21	1.7317	15
16	25	6,325	253.00	9.040	13.35	1168.10	1.8009	16
17	30	6,300	210.00	7.533	15.10	1154.75	1.8730	17
18	35	6,270	179.14	6.457	17.28	1139.35	1.9479	18
19	40	6,235	155.88	5.650	18.98	1122.07	2.0258	19
20	45	6,195	137.66	5.022	20.54	1103.09	2.1068	20
21	50	6,150	123.00	4.520	21.94	1082.55	2.1911	21
22	55	6,100	110.91	4.109	23.21	1060.61	2.2788	22
23	60	6,045	100.75	3.767	24.34	1037.40	2.3699	23
24	65	5,985	92.08	3.177	25.36	1013.06	2.4617	24
25	70	5,920	84.57	3.229	26.26	987.70	2.5633	25
26	74	5,850	79.05	3.051	26.69	961.44	2.6658	26
27	78	5,776	74.05	2.897	27.05	934.75	2.7725	27
28	82	5,698	69.49	2.756	27.35	907.70	2.8834	28
29	86	5,616	65.30	2.628	27.58	880.35	2.9987	29
30	90	5,530	61.44	2.511	27.75	852.77	3.1187	30
31	94	5,440	57.87	2.404	27.87	825.02	3.2434	31
32	98	5,346	54.55	2.306	27.94	797.15	3.3731	32
33	102	5,248	51.45	2.216	27.96	769.21	3.5081	33
34	106	5,146	48.55	2.132	27.94	741.25	3.6484	34
35	110	5,040	45.82	2.055	27.87	713.31	3.7943	35
36	114	4,930	43.25	1.982	27.78	685.44	3.9461	36
37	118	4,816	40.81	1.915	27.65	657.66	4.1039	37
38	122	4,698	38.51	1.852	27.49	630.01	4.2681	38
39	126	4,576	36.32	1.793	27.29	602.52	4.4388	39
40	130	4,450	34.23	1.738	27.08	575.23	4.6164	40
41	134	4,320	32.24	1.687	26.84	548.15	4.8010	41
42	138	4,186	30.33	1.638	26.58	521.31	4.9931	42
43	142	4,048	28.51	1.591	26.30	494.73	5.1928	43
44	146	3,906	26.75	1.548	25.99	468.43	5.4005	44
45	150	3,760	25.07	1.507	25.68	442.41	5.6165	45
46	154	3,610	23.44	1.468	25.35	416.76	5.8412	46
47	158	3,456	21.87	1.430	25.01	391.41	6.0748	47
48	162	3,298	20.36	1.395	24.66	366.40	6.3178	48
49	166	3,136	18.89	1.361	24.29	341.74	6.5705	49
50	170	2,970	17.47	1.329	23.92	317.45	6.8333	50
51	174	2,800	16.09	1.299	23.54	293.53	7.1067	51
52	178	2,626	14.75	1.270	23.16	269.99	7.3910	52
53	182	2,448	13.45	1.242	22.77	246.83	7.6866	53
54	186	2,266	12.18	1.215	22.38	224.06	7.9941	54
55	190	2,080	10.95	1.189	21.98	201.68	8.3138	55
56	194	1,890	9.74	1.165	21.57	179.70	8.6464	56
57	198	1,696	8.57	1.141	21.17	158.13	8.9922	57
58	202	1,498	7.42	1.119	20.77	136.96	9.3519	58
59	206	1,296	6.29	1.097	20.37	116.19	9.7260	59
60	210	1,090	5.19	1.076	19.97	95.82	10.1150	60
61	214	880	4.11	1.056	19.56	75.85	10.5196	61
62	218	666	3.06	1.037	19.16	56.29	10.9404	62
63	222	448	2.02	1.018	18.76	37.13	11.3780	63
64	226	226	1.00	1.000	18.37	18.37	11.8332	64

Hypothetical Experience of Staff Pension Fund.

TABLE 13.

Commutation Columns for finding Present Value of Future Salary, and Return of Contributions at Death, without Interest.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	D_x^s $= D_x^4 \times s_x$	rD_x^s $= D_x^s \div 1.04$	Π_x^s $= \Sigma_x^{64}(rD_x^s)$	${}^dM_x^s$ $= {}^dM_x \times s_x$	${}^dR_x^s$ $= \Sigma {}^dM_x^s$	Age (x)
15	222,120	213,577	7,591,371	12,870	1,086,826	15
16	246,025	236,562	7,380,797	15,128	1,073,956	16
17	257,460	247,558	7,111,235	17,106	1,058,828	17
18	261,115	251,361	6,896,677	18,851	1,041,722	18
19	262,040	251,962	6,645,316	20,424	1,022,871	19
20	260,730	250,702	6,393,351	21,818	1,002,447	20
21	257,950	248,029	6,142,652	23,135	980,599	21
22	254,510	244,750	5,891,623	24,310	957,461	22
23	250,500	240,865	5,649,873	25,374	933,151	23
24	246,350	236,875	5,409,008	26,315	907,780	24
25	241,850	232,548	5,172,133	27,244	881,435	25
26	234,136	225,131	4,939,585	27,683	854,191	26
27	226,824	218,100	4,711,454	28,041	826,508	27
28	219,812	211,387	4,496,354	28,356	798,467	28
29	213,191	204,994	4,281,967	28,638	770,111	29
30	206,640	198,692	4,079,973	28,863	741,473	30
31	200,408	192,709	3,881,281	29,027	712,610	31
32	194,432	186,954	3,688,581	29,145	683,583	32
33	188,598	181,314	3,501,627	29,213	654,438	33
34	182,850	175,817	3,320,283	29,246	625,225	34
35	177,130	170,606	3,144,466	29,238	595,979	35
36	172,140	165,519	2,973,860	29,161	566,741	36
37	166,852	160,435	2,808,341	29,052	537,580	37
38	161,772	155,550	2,647,906	28,877	508,528	38
39	156,870	150,837	2,492,356	28,652	479,651	39
40	151,970	146,125	2,341,519	28,366	450,999	40
41	147,132	141,473	2,195,391	28,033	422,633	41
42	142,416	136,938	2,053,921	27,641	394,600	42
43	137,740	132,442	1,916,983	27,179	366,959	43
44	133,152	128,031	1,784,511	26,674	339,780	44
45	128,700	123,750	1,656,510	26,100	313,106	45
46	124,278	119,498	1,532,760	25,425	287,006	46
47	119,761	115,158	1,413,262	24,680	261,581	47
48	115,506	111,063	1,298,104	23,879	236,901	48
49	111,054	106,783	1,187,011	22,991	213,022	49
50	106,760	102,654	1,080,258	22,015	190,031	50
51	102,660	98,712	977,604	20,984	168,016	51
52	98,434	94,648	878,892	19,900	147,032	52
53	94,094	90,475	784,244	18,728	127,132	53
54	89,838	86,383	693,769	17,481	108,404	54
55	85,690	82,304	607,386	16,169	90,920	55
56	81,092	77,973	524,992	14,763	74,751	56
57	76,626	73,679	447,019	13,266	59,988	57
58	71,912	69,146	373,340	11,716	46,722	58
59	66,950	64,375	304,194	10,094	35,006	59
60	61,740	59,365	239,819	8,421	24,912	60
61	56,282	54,117	180,454	6,698	16,191	61
62	50,140	48,212	126,337	4,970	9,793	62
63	43,734	42,052	78,125	3,211	4,823	63
64	37,516	36,073	36,073	1,582	1,582	64

Hypothetical Experience of Staff Pension Fund.

TABLE 14.

Commutation Columns for finding the Present Values of Return of Contributions, on Withdrawal and Early Retirement.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	${}^wM_x^s$ $= {}^wM_x \times s_x$	${}^wR_x^s$ $= \sum {}^wM_x^s$	${}^rM_x^s$ $= {}^rM_x \times s_x$	${}^rR_x^s$ $= \sum {}^rM_x^s$	Age (x)
15	115,580	1,611,937	3,487	799,352	15
16	124,450	1,496,357	4,358	795,865	16
17	124,020	1,371,907	5,231	791,507	17
18	118,405	1,247,887	6,102	786,276	18
19	111,240	1,129,482	6,974	780,174	19
20	103,500	1,018,242	7,846	773,200	20
21	95,550	914,742	8,717	765,354	21
22	87,890	819,192	9,590	756,637	22
23	80,640	731,302	10,461	747,947	23
24	73,840	650,662	11,332	736,586	24
25	67,480	576,822	12,205	725,254	25
26	60,754	509,312	13,002	713,949	26
27	54,678	448,588	13,599	700,147	27
28	49,118	393,910	14,296.7	686,547.9	28
29	44,118	344,792	14,939.1	672,251.2	29
30	39,510	300,674	15,578.1	657,312.1	30
31	35,344	261,161	16,186.8	641,734.0	31
32	31,556	225,820	16,763.9	625,547.2	32
33	28,152	194,264	17,335.9	608,783.3	33
34	25,016	166,112	17,875.8	591,447.4	34
35	22,110	141,096	18,410.7	573,571.6	35
36	19,494	118,986	18,913.7	555,160.9	36
37	17,110	99,492	19,412.2	536,247.2	37
38	14,884	82,382	19,877.5	516,835.0	38
39	12,852	67,498	20,311.2	496,957.5	39
40	11,050	54,646	20,711.6	476,646.3	40
41	9,380	43,596	21,080.9	455,934.7	41
42	7,866	34,216	21,417.6	434,853.8	42
43	6,532	26,350	21,723.2	413,436.2	43
44	5,402	19,818	21,997.8	391,713.0	44
45	4,350	14,416	22,240.5	369,715.2	45
46	3,388	10,066	22,428.6	347,474.7	46
47	2,528	6,678	22,560.8	325,046.1	47
48	1,782	4,150	22,639.5	302,485.3	48
49	1,162	2,368	22,664.0	279,845.8	49
50	680	1,206	22,611.7	257,181.8	50
51	348	526	22,484.3	234,570.1	51
52	178	178	22,260.7	212,085.8	52
53	...	...	21,941.9	189,825.1	53
54	...	...	21,507.2	167,883.2	54
55	...	...	20,958.9	146,376.0	55
56	...	...	20,278.8	125,417.1	56
57	...	...	19,427.8	105,138.3	57
58	...	...	18,388.1	85,710.5	58
59	...	...	17,102.1	67,322.4	59
60	...	...	15,437.1	50,220.3	60
61	...	...	13,325.8	34,783.2	61
62	...	...	10,586.1	21,457.4	62
63	...	...	7,235.0	10,871.3	63
64	...	...	3,636.3	3,636.3	64

The figures in old-faced type in the Column ${}^rM_x^s$ are the values of $s_x \times {}^rM_{28}$, and in Column ${}^rR_x^s$ are the continuous summation of Column ${}^rM_x^s$.

Hypothetical Experience of Staff Pension Fund.

TABLE 15.

Commutation Columns for finding the Values of Return of Contributions, with Compound Interest on Death or Early Retirement.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	${}^dD_x^s$ = ${}^dD_x \times s_x$	${}^d\overline{D}_x^s$ = $\sum {}^dD_x^s$	${}^rD_x^s$ = ${}^rD_x \times s_x$	${}^r\overline{D}_x^s$ = $\sum {}^rD_x^s$	Age (x)
15	31,720	1,951,234	17,550	1,644,896	15
16	37,200	1,922,514	21,093	1,627,346	16
17	41,910	1,885,314	24,339	1,606,253	17
18	45,955	1,843,404	27,302	1,581,914	18
19	49,400	1,797,419	30,003	1,554,612	19
20	52,380	1,748,049	32,456	1,524,609	20
21	51,850	1,695,669	34,674	1,492,153	21
22	56,925	1,640,819	36,674	1,457,479	22
23	58,620	1,583,894	38,472	1,420,805	23
24	59,930	1,525,274	40,075	1,382,333	24
25	60,970	1,465,344	41,497	1,342,258	25
26	60,902	1,404,374	42,180	1,300,761	26
27	60,684	1,343,472	42,749	1,258,581	27
28	60,270	1,282,788	43,214	1,215,832	28
29	59,684	1,222,518	43,516	1,172,618	29
30	59,040	1,162,834	43,740	1,129,102	30
31	58,186	1,103,794	43,898	1,085,362	31
32	57,232	1,045,608	43,904	1,041,464	32
33	56,202	988,376	43,758	997,560	33
34	55,120	932,174	43,672	953,802	34
35	53,900	877,054	43,450	910,130	35
36	52,668	823,154	43,092	866,680	36
37	51,330	770,486	42,716	823,588	37
38	49,898	719,156	42,334	780,872	38
39	48,384	669,258	41,832	738,538	39
40	46,930	620,874	41,210	696,706	40
41	45,292	573,944	40,602	655,496	41
42	43,608	528,652	39,882	614,894	42
43	42,032	485,044	39,192	575,012	43
44	40,296	443,012	38,398	535,820	44
45	38,550	402,716	37,650	497,422	45
46	36,806	364,166	36,806	459,772	46
47	34,918	327,360	35,866	422,966	47
48	33,048	292,442	34,830	387,100	48
49	31,042	259,394	33,864	352,270	49
50	29,240	228,352	32,640	318,406	50
51	27,144	199,112	31,494	285,766	51
52	25,276	171,968	30,260	254,272	52
53	23,296	146,692	29,120	224,012	53
54	21,204	123,396	27,714	194,892	54
55	19,190	102,192	26,220	167,178	55
56	17,266	83,002	24,638	140,958	56
57	15,246	65,736	22,968	116,320	57
58	13,130	50,490	21,210	93,352	58
59	11,124	37,360	19,158	72,142	59
60	9,030	26,236	16,800	52,984	60
61	7,062	17,206	14,124	36,184	61
62	5,232	10,144	11,118	22,060	62
63	3,330	4,912	7,326	10,942	63
64	1,582	1,582	3,616	3,616	64

NOTE.—The figures in old-faced type in column ${}^rD_x^s$ are the values of $\{{}^rD_{28 \times (1+i)^{28-x}} \times s_x\}$, and in ${}^r\overline{D}_x^s$ are the continuous summation of ${}^rD_x^s$.

Hypothetical Experience of Staff Pension Fund.

TABLE 16.

Commutation Columns for finding the Value of Pension of (s) per annum for every Year of Service, upon Early Retirement where (s) equals

(a) *Average Salary.*(b) *Last Salary.*

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	AVERAGE SALARY		LAST SALARY			Age (x)
	${}^{ra}M_x^s$ $= {}^{ra}M_x \times s_x$	${}^{ra}R_x^s$ $= \sum {}^{ra}M_x^s$	${}^{ra}C_x^{ls}$ $= ({}^rC_x \times a'_{x+1} \times s_x)$	${}^{ra}M_x^{ls}$ $= \sum {}^{ra}C_x^{ls}$ (corrected to nearest integer)	${}^{ra}R_x^{ls}$ $= \sum {}^{ra}M_x^{ls}$	
28	120,372	5,774,642	366.5	278,242	8,192,581	28
29	125,859	5,654,270	377.5	277,875	7,914,339	29
30	131,318	5,528,411	375.1	277,498	7,636,464	30
31	136,554	5,397,093	380.2	276,922	7,358,966	31
32	141,551	5,260,539	391.8	276,142	7,082,044	32
33	146,502	5,118,988	1,005.7	275,347	6,805,902	33
34	151,202	4,972,486	1,018.7	274,342	6,530,555	34
35	155,850	4,821,284	1,232.0	273,323	6,256,213	35
36	160,241	4,665,434	1,240.3	272,091	5,982,890	36
37	164,579	4,505,193	1,469.1	270,551	5,710,799	37
38	168,639	4,340,614	1,682.4	269,382	5,439,948	38
39	172,431	4,171,975	1,911.4	267,699	5,170,566	39
40	175,933	3,999,544	2,124.2	265,788	4,902,867	40
41	179,157	3,823,611	2,349.0	263,664	4,637,079	41
42	182,085	3,641,154	2,564.0	261,315	4,373,415	42
43	184,725	3,462,369	2,774.7	258,751	4,112,100	43
44	187,076	3,277,644	2,995.9	255,976	3,853,349	44
45	189,123	3,090,568	3,400.5	252,980	3,597,373	45
46	190,675	2,901,445	3,819.2	249,580	3,344,393	46
47	191,709	2,710,770	4,212.3	245,760	3,094,813	47
48	192,244	2,519,061	4,605.7	241,548	2,849,053	48
49	192,272	2,326,817	5,194.1	236,942	2,607,505	49
50	191,585	2,134,545	5,759.6	231,748	2,370,563	50
51	190,198	1,942,960	6,485.0	225,989	2,138,815	51
52	187,936	1,752,762	7,193.0	219,504	1,912,826	52
53	184,805	1,564,826	8,066.2	212,311	1,693,322	53
54	180,623	1,380,021	8,915.0	204,244	1,481,011	54
55	175,400	1,199,398	9,861.0	195,329	1,276,767	55
56	169,024	1,023,998	11,129.8	185,468	1,081,438	56
57	161,150	854,974	12,466.1	174,339	895,970	57
58	151,688	693,824	14,222.8	161,873	721,631	58
59	140,187	542,136	17,102.1	147,650	559,758	59
60	125,475	401,949	20,181.0	130,548	412,108	60
61	107,300	276,474	24,586.5	110,367	281,560	61
62	84,259	169,174	28,477.3	85,780	171,193	62
63	56,805	84,915	29,193.0	57,303	85,413	63
64	28,110	28,110	28,109.9	28,110	28,110	64

Hypothetical Experience of Staff Pension Fund.

TABLE 17.

Multipliers for use in the Valuation.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (<i>x</i>)	$(N_{65} + \frac{1}{2}D_{65})$ $\div D_x$	$\frac{M_x^s}{\div D_x^s}$	$\frac{dM_x}{\div D_x}$	$\frac{dR_x^s}{\div D_x^s}$	$\frac{wM_x}{\div D_x}$	$\frac{wR_x^s}{\div D}$	$\frac{rM_x}{\div D_x}$	$\frac{rR_x^s}{\div D_x^s}$	Age (<i>x</i>)
15	·101	34·190	·058	4·893	·520	7·257	·016	3·599	15
16	·114	30·000	·061	4·365	·506	6·082	·018	3·235	16
17	·130	27·749	·066	4·112	·482	5·329	·020	3·074	17
18	·150	26·382	·072	3·985	·453	4·774	·023	3·008	18
19	·171	25·359	·078	3·904	·425	4·310	·027	2·977	19
20	·193	24·521	·084	3·845	·397	3·905	·030	2·966	20
21	·217	23·813	·090	3·802	·370	3·546	·034	2·967	21
22	·242	23·157	·096	3·762	·345	3·218	·038	2·973	22
23	·268	22·554	·101	3·725	·322	2·919	·042	2·982	23
24	·295	21·957	·107	3·685	·300	2·641	·046	2·990	24
25	·324	21·386	·113	3·645	·279	2·385	·050	2·999	25
26	·354	21·096	·118	3·618	·259	2·175	·055	3·045	26
27	·385	20·785	·124	3·614	·241	1·978	·060	3·087	27
28	·417	20·453	·129	3·632	·223	1·792	·065	3·123	28
29	·451	20·099	·134	3·612	·207	1·617	·070	3·153	29
30	·487	19·745	·140	3·588	·191	1·455	·075	3·181	30
31	·525	19·367	·145	3·556	·176	1·303	·081	3·202	31
32	·564	18·971	·150	3·516	·162	1·161	·086	3·217	32
33	·605	18·567	·155	3·470	·149	1·030	·092	3·228	33
34	·649	18·159	·160	3·419	·137	·908	·098	3·235	34
35	·694	17·722	·165	3·359	·125	·795	·104	3·233	35
36	·741	17·276	·169	3·292	·113	·691	·110	3·225	36
37	·791	16·831	·174	3·222	·103	·596	·116	3·214	37
38	·844	16·368	·179	3·144	·092	·509	·123	3·195	38
39	·899	15·888	·183	3·058	·082	·430	·129	3·168	39
40	·957	15·407	·187	2·968	·073	·360	·136	3·137	40
41	1·019	14·921	·191	2·873	·064	·296	·143	3·099	41
42	1·084	14·421	·194	2·771	·055	·240	·150	3·053	42
43	1·154	13·917	·197	2·664	·047	·191	·158	3·002	43
44	1·227	13·402	·200	2·552	·041	·149	·165	2·942	44
45	1·304	12·871	·203	2·433	·034	·112	·173	2·873	45
46	1·387	12·334	·205	2·309	·027	·081	·180	2·796	46
47	1·476	11·801	·206	2·184	·021	·056	·188	2·714	47
48	1·569	11·238	·207	2·051	·015	·036	·196	2·619	48
49	1·673	10·689	·207	1·918	·010	·021	·204	2·520	49
50	1·782	10·119	·206	1·780	·006	·011	·212	2·409	50
51	1·897	9·523	·204	1·637	·003	·005	·219	2·285	51
52	2·024	8·929	·202	1·494	·002	·002	·226	2·155	52
53	2·164	8·335	·199	1·351	...	...	·233	2·017	53
54	2·317	7·723	·195	1·207	...	...	·239	1·869	54
55	2·481	7·088	·189	1·061	...	...	·245	1·708	55
56	2·677	6·474	·182	·922	...	...	·250	1·547	56
57	2·891	5·834	·173	·783	...	...	·254	1·372	57
58	3·143	5·192	·163	·650	...	...	·256	1·192	58
59	3·443	4·544	·151	·523	...	...	·254	1·006	59
60	3·806	3·884	·136	·404	...	...	·250	·813	60
61	4·255	3·206	·119	·293	...	...	·237	·618	61
62	4·865	2·520	·099	·195	...	...	·211	·428	62
63	5·680	1·786	·074	·110	...	...	·165	·249	63
64	6·741	·962	·042	·042	...	...	·097	·097	64

Hypothetical Experience of Staff Pension Fund.

TABLE 17—(continued).

Multipliers for use in the Valuation.

PENSION AGE 65.

INTEREST 4 PER-CENT.

Age (x)	$d D_x$ $\div D_x$	$d M_x^s$ $\div D_x^s$	$r D_x$ $\div D_x$	$r M_x^s$ $\div D_x^s$	$ra M_x$ $\div D_x$	$ra R_x^s$ $\div D_x^s$	$ra R_x^{ls}$ $\div D_x^s$	Age (x)
15	·143	8·798	·079	7·405	...	...	...	15
16	·151	7·814	·086	6·615	...	...	...	16
17	·163	7·323	·095	6·239	...	...	...	17
18	·176	7·052	·104	6·051	...	...	...	18
19	·189	6·859	·114	5·933	...	...	...	19
20	·201	6·704	·124	5·849	...	...	...	20
21	·213	6·574	·134	5·785	...	...	...	21
22	·224	6·446	·144	5·726	...	...	...	22
23	·234	6·323	·151	5·672	...	...	...	23
24	·243	6·192	·163	5·611	...	...	...	24
25	·252	6·059	·172	5·550	...	...	...	25
26	·260	5·998	·180	5·556	...	...	...	26
27	·268	5·923	·188	5·549	...	...	...	27
28	·274	5·835	·197	5·530	·548	26·267	37·266	28
29	·280	5·734	·204	5·500	·590	26·522	37·122	29
30	·286	5·627	·212	5·464	·636	26·754	36·956	30
31	·290	5·508	·219	5·416	·681	26·930	36·720	31
32	·294	5·378	·226	5·357	·728	27·056	36·425	32
33	·298	5·241	·232	5·289	·777	27·143	36·087	33
34	·301	5·098	·239	5·216	·827	27·194	35·715	34
35	·304	4·943	·245	5·129	·878	27·173	35·260	35
36	·306	4·782	·250	5·035	·931	27·103	34·756	36
37	·308	4·618	·256	4·936	·986	27·001	34·227	37
38	·308	4·446	·262	4·827	1·043	26·832	33·627	38
39	·308	4·266	·267	4·708	1·099	26·595	32·961	39
40	·309	4·086	·271	4·585	1·158	26·318	32·269	40
41	·308	3·901	·276	4·455	1·218	25·987	31·517	41
42	·306	3·712	·280	4·318	1·279	25·590	30·709	42
43	·305	3·521	·285	4·175	1·341	25·137	29·854	43
44	·303	3·327	·288	4·024	1·405	24·616	28·939	44
45	·300	3·129	·293	3·865	1·470	24·014	27·952	45
46	·296	2·930	·296	3·700	1·534	23·346	26·911	46
47	·292	2·733	·299	3·532	1·601	22·634	25·840	47
48	·286	2·532	·302	3·351	1·664	21·809	24·666	48
49	·280	2·336	·305	3·172	1·731	20·952	23·479	49
50	·274	2·139	·306	2·982	1·795	19·994	22·204	50
51	·264	1·940	·307	2·784	1·853	18·926	20·834	51
52	·257	1·747	·308	2·583	1·909	17·806	19·433	52
53	·248	1·559	·309	2·381	1·964	16·631	17·996	53
54	·236	1·374	·308	2·169	2·011	15·361	16·485	54
55	·224	1·193	·306	1·951	2·047	13·997	14·900	55
56	·213	1·024	·304	1·738	2·084	12·628	13·336	56
57	·199	·858	·300	1·518	2·103	11·158	11·693	57
58	·183	·702	·295	1·298	2·109	9·648	10·035	58
59	·166	·558	·286	1·078	2·094	8·098	8·361	59
60	·146	·425	·272	·858	2·032	6·510	6·675	60
61	·125	·306	·251	·643	1·906	4·912	5·003	61
62	·104	·202	·222	·440	1·681	3·374	3·414	62
63	·076	·112	·168	·250	1·299	1·942	1·953	63
64	·042	·042	·096	·096	·749	·749	·749	64

DISCUSSION.

Mr. A. D. BESANT said Mr. Manly had been peculiarly fortunate in discovering—to use his own words—a practically new field of research, and his paper was not only a monumental tribute of his actuarial genius, but also of his extraordinary industry and ingenuity in solving the very complicated problems which he had set himself to face. In fact, his paper constituted quite a text-book of the subject, giving exact and mathematical solutions of problems which had hitherto been considered as being beyond the scope of accurate calculation, and insoluble except by general methods of approximation. The chief points that called for discussion were

- (1) The data employed;
- (2) The construction of the tables;
- (3) The application of the tables.

With regard to the data, it would be of great interest if Mr. Manly would give further information as to the number of lives included in his investigation, and upon which he constructed his Table I, "Hypothetical Experience of Staff Pension Fund", set out on page 260. He asked this more particularly in regard to the normal q_x column. The rate of mortality there deduced—more especially at the earlier ages—was surprisingly low. Not only was it throughout much below that of the English Life Table, into which it merged at age 65, but it was also below that of the H^M Table up to about age 55, and at the younger ages it was even below the Institute Select Mortality. Again, the rate of withdrawal afforded much ground for comment. It would be seen in Table III that no less than 50 per-cent, or one-half of those who entered at age 15, had passed out of observation by withdrawal in the course of 10 years, while only rather less than $2\frac{1}{2}$ per-cent had passed out by death. Or, putting the same facts in other words, out of 40 entrants one person died in the 10 years and 20 withdrew. This subject had lately been very fully discussed in connection with Mr. Hunter's paper, and the general consensus of opinion seemed to be that while the lapse element under certain conditions might legitimately be introduced, yet it required to be handled—as Mr. King said—"with infinite caution", while Mr. Hardy went still further, and said that it was a most dangerous subject for an actuary to touch, and that even the most experienced would, if they were wise, think twice before they did so. Mr. Manly emphasized the same point, and he was so keenly alive to the dangers that he could only have introduced this heavy lapse ratio into his tables after the fullest investigation into the observed facts, and after making due allowance for a possible fall in the rate in the future. It would be most instructive to all the students amongst them if he would supplement Table I and Table 12, dealing with the salary question, by an introduction giving some detailed particulars of the data upon which they were constructed. Turning now to the question of the construction of the tables, it would be observed on page 211 that Mr. Manly assumed the withdrawals and deaths to occur at the end of the year. This assumption allowed him legitimately to add together the rates of death and

withdrawal to obtain the total decrement, and while it somewhat exaggerated the reduction of the l_x column, especially at the early ages where the numbers withdrawing were large, it was a convenient hypothesis for avoiding complication in the construction of the fundamental Tables 2, 3 and 4. He had made some independent calculations to obtain a modified column of $l_x^{(3)}$ corresponding to that printed in Table 3, but allowing for deaths and lapses being spread evenly throughout the year. The resulting figures, however, approximated so closely to those printed by Mr. Manly that the adjustment could, for all practical purposes, be ignored. To sum up, therefore, the basis of Mr. Manly's tables, they had

- (1) A light mortality element;
- (2) An exceedingly heavy lapse element;
- (3) A slightly exaggerated total decrement factor.

From the fundamental tables Mr. Manly proceeded to build up in the ordinary way commutation columns in Tables 5, 6 and 7. Passing to Table 9 and to the special features of the paper, the notation adopted required very careful attention. From the nature of the case the benefits to be valued vanished automatically upon attainment of the pension age 65, so that the Σ columns extend only to the summation of the facts included in the working ages 15 to 64. It would be noted, too, that the modified D'_x of Table 10 is obtained by multiplying the modified l'_x or Σr_x by v^{x+1} , in place of the usual v^x . So, too, in Table 11, the modified C, M and R columns were annuity functions and not assurance functions alone. These modifications were introduced for the sake of simplicity in the working formulas, and the methods by which the successive tables were built up deserved the most careful study. Turning now to the application of the tables, Mr. Manly proceeded to investigate a series of actuarial problems of the utmost interest, beginning with what he termed elementary problems, passing on to advanced problems, in which the further element of salaries was introduced, and ending up with a magnificent *tour de force* in Problem xii*b*, which would hitherto have been certainly considered as incapable of exact mathematical solution. Mr. Manly having supplied them with the theoretical formulas needed for valuing these complex benefits, and with a complete set of model tables, they next had to consider the practical difficulties of applying such models to actual cases of the valuation of pension funds. Mr. Manly himself did not minimize these difficulties. At the outset of his paper he mentioned how unstable are the data upon which the elaborate calculations have to be based, and the still greater danger which arises from the modification of the regulations enlarging the benefits every few years—often, too, without the actuary being informed of the change. To form a fair estimate of future salary, too, would need the greatest care and judgment, while even when a set of tables had been once prepared based on the past experience of any particular pension fund, the next valuation might disclose such differences in the data as would necessitate a re-calculation of the whole of the tables.

Mr. G. J. LIDSTONE said, Mr. Manly had expressed in his paper the fear that purists might consider that in some respects the

assumptions and methods pursued had not been sufficiently accurate. It appeared to him (Mr. Lidstone) that they were perfectly legitimate, and quite as accurate as the nature of the materials admitted of. It must be remembered that, however much time and care might be taken in erecting an elegant and refined edifice, it could never have any more stability than the materials upon which it was founded. In the present case the materials were not only uncertain, but were often actually shifting, and not the same from time to time. Considering first of all the rate of withdrawal which was assumed in the formula to be known and stationary, obviously the rate might vary within wide limits at different periods, owing to trade conditions and a number of other circumstances, and therefore experience of the fund might not be a safeguard in the future. An even greater difficulty arose when dealing with a new fund. One had then to utilize the experience of withdrawals before the fund was formed, but it was one of the principal objects of those funds—certainly one of their effects—to steady the service, and prevent withdrawals to a certain extent, for a man belonging to such fund thought twice before shifting his employment, and thus sacrificing years of pension service. It might, therefore, be that the rate of withdrawal deduced from the experience amongst the officials before the fund commenced would be quite unreliable for the valuation of the fund when it was once in existence. The question of average salary, as Mr. Besant had said, was even a more difficult one. Nothing was easier than to get out the average salaries enjoyed by officials at different ages at the present time, or over a series of years, to set them out graphically, and pass a smooth curve through them. Mr. Manly's spline was a fascinating little instrument, which made curve-drawing a pleasure, and the application of the graphic method a sort of half-holiday pastime. In one or two cases which had come before him, the salary curve had shown a marked tendency to a type, that of a blunt-headed hyperbola, with the axis cutting the base line at an angle of about 135 degrees. The curve rose steeply, but with very slight curvature, till about middle life, then twisted round until it became asymptotic to a line nearly parallel to the base line. But when the smooth curve had been deduced, could they be sure that it represented what they required, namely, the average salary which would be enjoyed in the future by lives at different ages? In many cases they could not. He believed it was usual in those cases to first of all eliminate the more highly-paid officials, those who might be called the general officers of the industrial army, and to deal with them separately—but the method of doing this was not simple, and he would like some further information as to how it should be done. But even when that was done, they were left with a considerable difficulty. It would frequently be found that at the higher ages the proportion of subordinate officers was considerably higher than it might be expected to be in future, when those who were young should have survived to middle age, or have reached the pension age. Mr. Manly had commented upon that, and suggested that some modification might have to be made in the figures. He felt sure that they would be glad to have further information as to how that modification should

be introduced. It might be extremely far-reaching in its effects, and the exact way in which it should be made was a very difficult problem, one which only great experience could solve. He did not propose that evening to discuss the pure mathematics of the paper, for the problems dealt with there were so numerous that they required considerable time for their assimilation. With regard to some of Mr. Besant's remarks, he (Mr. Lidstone) gathered that Mr. Manly did not put forward his rates of mortality and secessions as those which they could employ in practice; they were constructed in order to illustrate the subject, and bring the matter to the point of numerical calculation. Mr. Manly had studied and solved a series of most complicated problems, which would require time to deal with and digest, but it was quite obvious from the most casual glance that they had been solved with extreme ingenuity and elegance, and constituted almost the last word said on the subject. Mr. Besant had commented on the complication of the notation. That, of course, was inevitable from the nature of the subject, but he thought it would be of great assistance to all of them who intended to read the paper carefully, if the definitions could be collected together in one scheme, either at the end or at the commencement of the paper, so that anyone could study them before proceeding with the investigation and with the problems.

MR. PHILIP L. NEWMAN said, an examination of all the funds, with regulations similar to that under consideration, showed the same features—that of the light rate of mortality. Mr. Besant had expressed astonishment at it. He (Mr. Newman) could not say that he was astonished, because the conditions of life and service in those funds were of the best possible, and the weak ones always went out by retirement, or were invalided off, so that they did not die while unsuperannuated members of the fund. They went out of this class before they were superannuated, and showed a heavy death-rate, but those who remained in the class showed a light one. With regard to withdrawals and voluntary resignations, those differed widely in all the funds. But there was one notable feature, namely, that for many years the withdrawals had been getting less and less. Twenty years ago it was a very good thing for a young man to go into the service of one of the great railway companies, join their fund, spend some years in that service, and then enter commercial life outside. Now that the pressure of business was so much heavier they were unable to get work outside with the same facility, and therefore they remained on at their old employment. So that, as all the speakers had remarked, it was very dangerous to take the past experience of withdrawals to guide them in the future. With regard to the practical application of the tables, he would very much like to have Mr. Manly's opinion with regard to the average age of retirement, because that also had a distinct tendency to diminish. The age in one of the funds he was acquainted with used to be sixty-nine years, in another it was sixty-five, but it was now coming down to sixty-three, and probably in the future it would be about sixty, so the fact that the average pension age was gradually diminishing was a very important factor. What was the present position of most of those funds? Some of them had broken away from actuarial advice

altogether. One society he knew of, and, in fact, most of them, had raised the benefits much beyond what the valuation showed to be possible. He had particulars of the superannuation allowances, after forty-five years' service, of nine prominent societies. One of them formerly gave $72\frac{1}{2}$ per-cent of the average salary; now it gave 109 per-cent. Another used to give 67 per-cent, and it now gave $83\frac{3}{4}$ per-cent. The third gave 67 per-cent, and now gave 100 per-cent. In the next one there was no change. In the fifth the railway company had promised to contribute, if necessary, up to $83\frac{3}{4}$ per-cent of the salaries paid, instead of the usual $2\frac{1}{2}$ per-cent, in order to introduce a more liberal scale of superannuation. The next used to give 70 per-cent of the average salary, and now it was two-thirds of the average salary for the last seven years. Another gave 67 per-cent of the average salary, and now it was two-thirds of the average salary in the last seven years. The last one used to give 66 per-cent of the maximum, or "last" salary, and now gave 108 per-cent of the average salary. It could therefore be seen that the view taken by the managers of those funds, as distinct from the views of their professional actuarial advisers, was somewhat as follows:—If desirable benefits were provided by one company, all other companies should provide equivalent benefits. They went on to say that superannuation was another name for deferred pay, and that the general conditions of the service required that the officials should have adequate retiring allowances. If their attention was requested to the fact that a deficit was reported in the valuation, they stated that the directors took a broad commonsense view, and were not dominated by figures. They always added that even if they changed their benefits an increased contribution was not likely to be required. Sometimes they got the directors of the railway companies to specially sanction the increase of their benefits, and this, in his, (Mr. Newman's) opinion, was the only proper method of dealing with such cases, namely, that the directors of the company should guarantee their fund. If directors took the broad view that their men ought to have proper allowances on pension, let them give them their proper allowances. But they ought not to allow any of their societies to raise their benefits apart from actuarial sanction without such a guarantee. Of course, the point of view of actuaries in dealing with those funds was different from those of the managers of the funds. Their duty was primarily to see whether the fund was solvent upon the rules laid down. He did not see that they could take any other view than the strictly legal one on the question, but they should recognize that there was another view, namely, that of which he had spoken.

Mr. ARCHIBALD HEWAT was glad to see that Mr. Manly had referred to the many disturbing elements in valuations, and to how unstable were the data. Actuaries knew—though they could not always get laymen to understand it—there was no fixed age at which a man must retire who was connected with those funds, and, as a matter of fact, as long as a man was able to walk to the office, sit at a desk and hold a pen, he would do so, and continue to draw his salary. The consequence was that such men would never get a pension at all, or die very soon after retirement. He joined issue

with Mr. Manly in regard to the statement, "it is assumed that after age 65 the mortality rate is the same as the English Life Table No. 3." He begged to differ from that, because when a man retired before 65, he would not retire unless he was what we call an under-average life. Therefore, in regard to many of those, "selection" came largely into play. Again, the sudden retirement from the active duty of an official to the passive life of a pensioner was sometimes too great a change for many men to endure, and consequently if such a man did not get comfortably over the six or twelve months following his retirement, he would not draw his pension very long. With regard to those retiring because they were unfit for official duty, he had made a rough calculation, and found that if a man retired at 60 instead of 65, getting a pension of, say, $\frac{3.5}{6.0}$, instead of waiting until 65, and getting $\frac{4.0}{6.0}$ of his salary, he thereby "loaded" himself by 14 years, and was thus equal to a life of 74. With regard to the refunds, was it not sometimes to the advantage of the funds to pay back what had been paid in, without interest? That would, in most cases, be less than the present value of the pensions, and the actuary had to consider that point. He would say, that if a fund was to be started at all, to which the employers were to contribute, it should be inaugurated at a time when the salaries were being increased. It should then be compulsory on the employ  s to be connected with the fund. He thought those who were called upon to advise in regard to such matters should, as far as possible, recommend those who consulted them to make the fund or scheme as simple as possible. Promoters of such funds said they wished to provide pensions. The men asked that their contributions should be refunded if they left the service; this introduced the savings bank element. Then it was asked, "If I die, what about my widow and children?" This again introduced the life assurance element. With regard to secession, one ought to be careful, because the rate of secession in the future with a fund or scheme would be very different from the rate before, when there was no such scheme. After the establishment of the fund there was something to keep the men in their employ—something which induced them to stay as long as possible. Another way of looking at the matter was, that allowance ought to be made, when framing a scheme, for the fact that a man was drawing say £600 a year at the time of retirement often merely because he had been forty years in the service. But a young man, on £150 a year, would generally be glad of the post at £250. The difference between those two salaries should go to the credit of the scheme, after allowing for increases year by year in the salaries of those promoted by the vacancy. The proportion of higher paid officials retiring at one time might vary greatly. At one time one or two men at £450 a year might retire; at another two or three at £100 only. That would disturb the result in much the same way as the claims in a life office falling on large sums assured instead of on small. He looked upon pension schemes largely from the deferred-pay point of view. It had been mentioned that one of the benefits of a pension fund was that men would be less ready to leave the service. He thought that might sometimes act as a disadvantage, because the employer might possibly wish to get rid of some of them.

MR. T. G. ACKLAND said, with regard to the withdrawals, he would also have liked to have had some particulars of the materials from which the resulting rate was deduced. In the formation of new funds it was difficult to obtain any data as to the probable rate of retirement, and sometimes an existing company, especially if a small one, had no facts available as to withdrawals, or they were so scarce that they did not afford any satisfactory data. The practice, perhaps a reprehensible one, in such cases had been, he believed, occasionally followed of ignoring withdrawals altogether. Perhaps Mr. Manly could tell them in some future paper what would be the effect upon the fund if the element of withdrawal were ignored. Seeing that the contributor only, as a rule, drew back some part of the total contribution made on his account, the case was perhaps in some respects analogous to that of an insurance policy where a surrender-value, well within the reserve-value, was allowed, but where they did not usually provide for a rate of secession in their calculations. There were two subjects having relation to the question of pension funds which he would like to have seen dealt with by the authors of the paper. The first was as to the matter of a stationary staff. It was well known that, upon the assumption that lives passing out of observation by death, withdrawal, or retirement, were at once replaced uniformly by new entrants of a specified age, the fund would in course of time tend to a stationary position, in which the number of members at the several ages, and the annual amount of their salaries and contributions, and of the sums payable as pensions, as well as those in respect of death benefits and withdrawals, were all uniform and invariable. In this state of things the investigation of some of the problems dealt with by Messrs. Manly and Thomas became much simplified, and he (Mr. Ackland) had found that the solution of the problems arising in respect of a stationary staff was most useful as a check upon the more complicated problems dealt with on the lines set out in the paper.

The second point upon which he would have liked to have heard more was on the question of new entrants. Mr. Manly had dealt throughout with the valuation of a fund having members existing at certain ages, when all that was necessary was to trace them through the remainder of their membership. But in connection with the formation of a new fund, and also in some questions arising on existing funds, one had to deal with fresh entrants, who might usually be assumed to come in at a specified early age. The matter came before him recently in a very definite and troublesome form in connection with a pension scheme proposed to be started by a large City Corporation, where the question was definitely put to him, "What will be the probable annual charge upon the city rates during the next ten years, during the subsequent ten years, and so on for fifty years, supposing that the present staff is adequate in number for the needs of the corporation, and that new entrants come in only in replacement of those who die, withdraw, or retire?" Or to put the problem more definitely, and in a somewhat different form: Given m lives aged x who are subject to a known rate of decrement year by year, and whose salaries vary yearly, according to age, upon an ascertained scale; and assuming that all lives passing out of observation are immediately

replaced by lives aged w (where w represents a uniform age not greater than x), and that these substituted lives are subject to the same rates of decrement, and receive the same scale of salary (according to age), as the original body of lives; what will be the total amount of salary paid to the m lives in the t th year from the present time? That was a question which he found to be one of considerable difficulty. He had tried to deal with it theoretically, and after failing himself, he had submitted it to three or four of the junior Fellows of the Institute, all of whom were eminent for their mathematical attainments, as well as for their actuarial capabilities. Those gentlemen had come to the conclusion, after painstaking investigation, that the problem was intractable, if not insoluble, by our ordinary methods. It was necessary to deal with it practically, however, and he therefore had to solve it by methods of approximation, which were always somewhat unsatisfactory. It would be a real boon if some member of the Institute would investigate this general problem, which appeared to him to be at the root of these Pension Fund investigations, and indicate the way to a satisfactory solution.

Mr. R. P. HARDY had listened very carefully to the discussion, and he thought there was some risk of doing injustice to Mr. Manly. Mr. Manly was aware that those funds were only solemn truces between employer and employed. It was perfectly understood on both sides what they meant, and that was the true explanation of the somewhat unceremonious way in which managers of those funds put aside the very lengthy and, no doubt, carefully prepared reports of actuaries. The employer, in the last resort, stood behind the scheme; he had brought his servants into it, and had made it a condition of their employment, and therefore was bound to see it through. He spoke from personal experience upon that point, and, moreover, the management of the fund was bound to consent to such further amendments as might be necessary to keep the service as a going concern. That being so, beyond the mere speculative interest of such matters, there was no necessity for troubling themselves with many refinements. There was only one formula on which he would venture to differ from Mr. Manly, and he would ask him to reconsider the method adopted in arriving at the average salary. The whole of the questions turned upon the particular salary deduced, namely, the surface upon which the contributions were to be reckoned, and upon which the pension was to be calculated. In that respect he (Mr. Hardy) had been a sinner himself. For many years he did exactly as Mr. Manly had sketched, but he had learnt since—and if Mr. King had been present he would have said the same—that the method contained a fatal weakness. It was impossible, with the limited experience generally before them, to get a sufficiently proper spread of the salaries such as they were likely to show when the funds had been at full work for many years. It had, therefore, become necessary to check the average salary obtained by Mr. Manly's method against one which was deduced by the old-fashioned system of groups. That grouping was a very important matter. It was a very distressing task to analyse the staff of a great railway company. One found, say, a Colonel with the pay of a general officer, a sprinkling

of officers, and a few sergeants and non-commissioned officers, and a mass of rank and file whose outlook in life was distinctly limited, who practically were unable to rise, and, as a fact, never did rise. They represented nothing but pure labour, wielding a pen instead of the jack-plane. It was, therefore, not so difficult—he did not say it was easy—to group those members so as to supply what he thought would be a substantial adjustment of the salary as above deduced.

The PRESIDENT said there was no doubt that the Fellows would all wish to accord a very hearty vote of thanks to Mr. Manly and to Mr. Thomas for their admirable presentation, and in acknowledging it Mr. Manly might perhaps make a few remarks. He would, however, first call upon Mr. Thomas.

The vote was carried with acclamation.

Mr. E. C. THOMAS said, that in response to the kind invitation of the President, he would like to make a few remarks, but he would confine himself to statistical matters. Mr. Besant asked for further information as to the number of lives included in the investigations on which the calculations were based. They had not the original data to work upon. The rates of mortality, withdrawal, &c., were calculated from the rates actually used in the valuations of the various funds. These were averaged and roughly graduated by the method mentioned by Mr. Manly. With regard to withdrawals, Mr. Besant took exception to the fact that the withdrawal rate was a high one, and he thought it was dangerous to use a withdrawal rate at all. But he asked him to bear in mind that in the funds which were examined and referred to in the paper throughout membership was compulsory. In those circumstances the rate of withdrawal was a necessary part of the calculations. With regard to the rate of salary, it would be seen in the column given that the scheme of salaries used was one progressing by increments of 5 for the first ten ages, and thereafter by increments of 4, a purely arbitrary table, but one which represented on the whole fairly accurately the average rates of the funds in question. Of course it was quite obvious that it would be impossible to produce any table involving three or four forces at work simultaneously, as happened in the present case, which would be suitable for use in the valuation of any given fund. Even if the forces of withdrawal and superannuation were as likely to represent the experience in a given fund as was the force of mortality, still, the probability of the table being a suitable one would be of course considerably lessened by the fact that there were three or four of those forces instead of only one to deal with. As a fact, in the case of the withdrawals and the retirements, there were very considerable differences in the funds which were examined by Mr. Manly and himself, and, particularly with regard to the retirements, for ages under fifty they had to depend almost entirely on the experience of one fund, the probability being that in the other funds those who were invalided off at the early ages were treated exceptionally, a commutation of pension being paid in a lump sum, and the lives being thrown in among the withdrawals. With regard to the construction of the tables, as Mr. Manly mentioned, they were constructed in the inverse order to that in which they were numbered.

Table 4, involving the triple force, was calculated first, and, having obtained the columns l_x , d_x , w_x , and r_x , the column r_x was taken out and treated separately by the assumed death rate of 10 per-cent., decreasing to 4.71, the English Life rate. By that rate of mortality, a column of survivals, allowing for those coming on at each age, and a column of deaths were calculated; and those columns of survivals and deaths were added to the original l_x and d_x columns, in order to form similar columns for Table 3. From those modified columns a new q_x was formed, which was called the modified q_x , and that was made the basis of Table 2.

Mr. MANLY said he proposed to do little more than thank the members heartily and sincerely for the manner in which they had received the paper. It had been suggested more than once that possibly the value of the paper would be increased if a key to the notation were made and included. He did not think that it would help the members very much, because the symbol was intended to represent the problem and its solution. He feared that before any member could understand the symbol it would be necessary for him to go through the investigation of the problem and its solution. After that the symbol became intelligible and a living representation. With regard to the data, Mr. Thomas had dealt well with that point. It would be no help to state what the original observations were, but, taking together all the funds which were laid under contribution, one might say they represented an experience of probably 30,000 lives, passing through an average of 10 years' observation. That did not constitute a bad basis, as far as construction was concerned. Although the rate of withdrawal seemed very heavy, it must be remembered that, after all, that rate of withdrawal operated only in very early years, when young fellows went into the service with no intention of stopping there and left it very soon. The rate was not very heavy after the age of 25, and the rate of withdrawal given in the tables was almost the lowest of any in the funds. He and Mr. Thomas took very great care not to make the rate of withdrawal too high. Rate of withdrawal was, of course, a very difficult subject to deal with, especially if the fund were a small one. In such case it was better, he thought, to assume that there would be no withdrawal. His rate was only an average of a large number of cases spread over a large number of years. There was no law of secession, and all they could do was to reduce everything to averages. The same remark might he made with regard to salaries, though he was not so much troubled about salaries as Mr. Hardy appeared to be. What they had to consider was not so much the actual salaries as the average increase in those salaries. When the multiplier was obtained, they had only to multiply it into the salary which was being paid. Taking all the salaries which were being paid, was it possible, within reasonable limits, to arrive at the probable increase which would take place in all those salaries taken together year by year? He thought it was; and he found that a common annual rate of increase of salary applied to almost all the funds he had had to deal with. If a man was in receipt of £400 a year he would not hesitate to treat him in the same way as all the others. Whether a man received £400 or £1,000, if one multiplied all the salaries by the proper multiplier, a very

reasonable total result would be arrived at—in fact, the most probable result, and it was that they strove after. In his opinion, however, the withdrawal was more serious than the rate of salary, because if the withdrawals were estimated too highly, one would over-estimate the profit to the fund and under-estimate the survivors who would claim the benefits of the fund. In the part of the paper where he talked of the valuation of exerescences, he pointed out that it was far better to make broad assumptions first and then afterwards make adjustments. It must also be so with these funds.

REVIEW.

Lectures on the Law of Mortgage. By W. G. HAYTER.*

IN the issue of this *Journal* for January 1901 it was intimated that the Council of the Institute of Actuaries, in further continuance of the plan adopted in 1896, had arranged for the delivery before the members of the Institute, during the Session 1900–1901, of a course of lectures on the Law of Mortgage. The lectures having been duly delivered by Mr. Hayter, and received with great appreciation by his audience, have now been published in book form, and it may be confidently predicted that actuarial students will welcome the appearance of the volume, which forms a worthy addition to the three courses of lectures already delivered and published under the same auspices.

With reference to the form, as distinguished from the subject-matter, of the book, it is to be regretted that the admirably-conceived detailed syllabus already given in the *Journal* (*J.I.A.* xxxv, 489) has not been reprinted—possibly with some slight modification—as a Table of Contents prefixed to the Lectures, and the index relegated to its usual place at the end of the volume. The index itself might, with advantage, have been fuller; for instance, “Consolidation” does not appear therein, “Contributory Mortgage” is indexed under “Mortgage” only, while “Equitable Mortgage” will be found under both the appropriate headings; the Policies of Assurance Act, 1867, is indexed but not the Judicature Act, 1873. It may also be suggested that in the body of the work short headings to the paragraphs, indicating the subject next to be dealt with, would have been of assistance to the student.

In the Preface, which appears over initials that may be recognized as those of the President of the Institute, attention is drawn to the fact that the lectures deal only with the broad outlines of the law of the subject and that the niceties of the law have not been touched upon. That this should be so is, from the necessities of the case,

* The Law of Mortgage: A Course of Lectures. By W. G. Hayter, Barrister-at-Law. Delivered at the Institute of Actuaries, Staple Inn Hall, during the Session 1900–1901. London: C. & E. Layton, 56, Farringdon Street, E.C.

unavoidable, and, while opinions may perhaps differ as to the amount of legal knowledge it is desirable for an actuary to have, it is obvious that the student, for whose use the lectures are primarily intended, cannot be expected, in the first instance at any rate, to go beyond general principles. It is from this standpoint that the lectures should be judged, and while it would no doubt be possible to point out instances in which some of the propositions contained in the work might be amplified or qualified, this would not be fair to the lecturer. His task—to prepare a set of lectures suitable for the requirements of students in the first instance, and members of the Institute generally—was no easy one; that it has been admirably performed is obvious even on a first reading of the volume. The logical arrangement of the matter shown in the original syllabus has been carried out with consistency and but little room can be found for criticism.

On page 8, with reference to the covenant to pay interest without any deduction, it might perhaps have been mentioned that the mortgagor has the right to deduct income tax from the interest payable, and that any agreement for payment of interest in full without deduction of income tax will be void. It may also be noted that in mortgages of policies of life assurance (page 30) it is desirable to insert in the deed a provision that the power of sale may be exercised by way of surrender to the issuing office.

The references to the special subject of mortgages of reversionary interests (pages 33–37) might, perhaps, have been somewhat modified if the lecturer had had practical acquaintance with the desires of reversioners and the methods of carrying out advances to them. A mortgage of an absolute, or vested, reversion containing a clause that the interest shall roll up until the reversion falls in is of very rare occurrence in practice. It is obvious that, in settling the amount of an advance to be made on these lines, the lender must discard the principle of averages underlying the valuation of reversionary interests and have regard to the maximum time for which the debt can possibly accumulate. The result would be that in all ordinary cases the amount that can be advanced would be only a small proportion of the actuarial value of the reversion—a result that would not be acceptable to the borrowing reversioner. Such mortgages in practice, therefore, almost invariably include the usual covenant for payment of interest and entitle the mortgagee, in the event of the interest not being paid, to the usual remedies of sale or foreclosure. If he elects to foreclose he should, if the amount of his original advance has been properly calculated, obtain the reversion as an investment (as distinguished from a security) in consideration of total payments, including interest and costs, amounting to not more than he would have been prepared to give for the reversion at the time of foreclosure absolute. So in the case of a contingent reversion, if the necessary policy be effected at a single premium, or arrangements be made for the commutation of the annual premium should it become necessary, the mortgagee can, it would appear, on foreclosure, place himself in a position corresponding to that of a purchaser of an absolute reversion to the amount assured by the policy, and the matter thus becomes merely one of actuarial valuation in the first instance.

The preface already referred to mentions that it has been suggested that on the occasion of future lectures the questions asked at the conclusion of each lecture and the answers given to them by the lecturer should be reported. It would have been very interesting had such a course been followed in the present case, as it is understood that the lecturer's answers to a question addressed to him as to the validity of provisions for capitalising mortgage interest have given rise to the considerable amount of discussion that has recently taken place on this subject. It has accordingly been thought that, although the point does not directly arise from the printed volume, it might usefully be referred to in the course of this review. The original question, shortly stated, is understood to have been as follows:—Where the mortgage deed contains a provision empowering the mortgagee, at his option, to capitalize interest not paid within a specified time, instead of having recourse to his usual remedies, can the mortgagee safely capitalize under this power interest falling due after he has received notice of a second mortgage? The answer to this question was in the negative, and it was further stated (*Insurance Record*, vol. xxxix. p. 123), that the same objections would apply where the mortgage deed contains, instead of an option to the mortgagee to capitalize, an express contract that interest shall be accumulated during a fixed term. Now it may be admitted that if the mortgage deed does not contain either of the above provisions, an agreement made between the mortgagor and mortgagee, after receipt by the latter of notice of a second charge, that a particular sum of interest shall be capitalized will be bad, inasmuch as the capitalized arrears of interest will be considered as a further advance which the first mortgagee cannot, by any agreement with the mortgagor, tack to his original loan as against a second mortgage of which he had notice at the time of his agreement (*Digby v. Craggs*). But if the deed contains an express provision that interest shall be capitalized, is the first mortgagee in a similar position? The contention that he is appears to rest upon a series of decisions, of which *Hopkinson v. Rolt*, and *West v. Williams* are perhaps the most important. The former case decided that a first mortgagee, whose mortgage is taken to cover further advances, but who has not covenanted to make them, cannot obtain priority for advances made after notice of a second mortgage, and the latter, that the same rule applies where the first mortgagee *has* covenanted to make further advances. The ground of the latter decision, as shown in the judgments (79 *L. T. Reports*, 576), appears to be that the mortgagor in such a case is under no obligation to take the further advances from the original mortgagee, and that the execution by him of a subsequent mortgage operates to discharge the first mortgagee from his covenant, with the effect that any further advances that he may make after notice of the second mortgage are, in reality, not compulsory but voluntary, and so fall within the rule of *Hopkinson v. Rolt*. It may, however, be argued that, in the case of a mortgage containing a firm contract to capitalize interest, nothing remains to be done by the first mortgagee, and the capitalized interest differs from the "further advances" in being already charged upon the property by the original deed; so that there is no question of the second mortgage preventing (to quote the

judgment of Lindley, M.R., in *West v. Williams*) the mortgagor from giving to the first mortgagee the agreed security for his further advances, and thus releasing him, the first mortgagee, from his obligation to make them. And even where the provision as to capitalization of interest is not a firm contract but an option to the mortgagee, the original contract is complete as regards the mortgagor and requires no further assent or dissent from him. It is satisfactory to note that counsel's opinions have been obtained to the effect that, upon the grounds shortly stated above, either a firm contract or an option to the mortgagee to capitalize interest may be reasonably relied upon as against a second mortgagee of whose charge the first mortgagee has had notice.

In the course of one of these opinions, a doubt has been expressed whether the ordinary option to capitalize interest in arrear might not be held to be a clog on the equity of redemption. Provisions for capitalization were originally, generally speaking, bad under the Usury laws, and it does not seem quite clear that even now, when those laws have been repealed, full reliance can be placed on such a provision. Mortgages of reversionary interests, the only case of practical importance, seem, however, to have been excepted from the rule, even while the Usury laws remained in force (*Howard v. Harris*). The opinion referred to states by implication that a firm contract to capitalize will not be considered as a clog upon the equity of redemption, and it is difficult to see why an option to the mortgagee to capitalize interest in arrear should be subject to a different rule. It must be remembered that when interest is thus capitalized, the mortgagor in effect receives compensation in the forbearance of the mortgagee to exercise any of his usual rights—of action on the covenant, foreclosure or sale. The characteristics of a clog were considered at length in the judgments in *Rice v. Noakes & Co., Ltd.* (82 *L. T. Rep.* 784). Rigby, L. J., stated (p. 789) that there must be a redemption in substance of the mortgaged property, that it must come back to the mortgagor not worse than when it was mortgaged, and that the mortgagee must not reserve to himself any hold upon the property after redemption—otherwise there will be a clog. If the incidents of a clog are correctly indicated in these statements, it is not easy to see how the ordinary option to capitalize can be brought within their purview, with the result that the option is to be treated as a clog.

Mr. Hayter's book may be strongly recommended to the student, and in fact to the profession generally, as containing in a small compass an extremely lucid description of the broad principles of the law relating to a most important and interesting subject.

J. E. F.

THE INSTITUTE OF ACTUARIES.

EXAMINATIONS OF THE INSTITUTE, APRIL 1901.EXAMINATION FOR ADMISSION TO THE CLASS OF ASSOCIATE
(PART I).*Examiner*—PROF. S. L. LONEY, M.A.*Supervisors*—MESSRS. B. A. BERRY, B.A., and G. J. LIDSTONE.*First Paper.*

1. If the manufacturer makes a profit of 10 per-cent, the middleman of $7\frac{1}{2}$ per-cent, and the shopkeeper of 15 per-cent, what was the cost to the manufacturer of goods which the shopkeeper sold for £45. 6s. 7d.?

2. Simplify the expressions—

$$(1) \frac{x^3 + (a+b)x^2 + (ab+1)x + b}{bx^3 + (ab+1)x^2 + (a+b)x + 1};$$

$$(2) \frac{\sqrt{12+6\sqrt{3}}}{\sqrt{3+1}}.$$

3. Solve the equations—

$$(1) \sqrt{5-x} + \sqrt{5+x} = \sqrt{3x+4};$$

$$(2) x^3 + y^3 = 35, x + y = 5.$$

4. A and B start at the same instant and each walks at a uniform rate, the former in x hours from P to Q, and the latter in y hours from Q to P. They meet on the road a hours before A arrives at Q, and b hours before B arrives at P; show that—

$$x : y :: \sqrt{a} : \sqrt{b}.$$

5. The population of a certain town at the end of any year is found by subtracting eleven times the population at the end of the previous year from ten times the population at the end of the succeeding year; also ten years ago the population was 11,000, and eleven years ago it was 10,000. Show that the population increases in geometrical progression.

6. Find the number of combinations of n things taken r together in each of which p of the given n things always occur.

How many different arrangements can there be made of 7 persons at a round table?

7. Prove the truth of the Binomial Theorem for a positive integral exponent.

If $(1+x)^n = c_0 + c_1x + c_2x^2 + \dots + c_nx^n$, show that

$$c_0c_2 + c_1c_3 + c_2c_4 + \dots + c_{n-2}c_n = \frac{2n}{n-2} \frac{n}{n+2},$$

and that $\frac{c_0}{1} - \frac{c_1}{2} + \frac{c_2}{3} - \dots + (-1)^n \frac{c_n}{n+1} = \frac{1}{n+1}$.

8. Prove that $\log_a mn = \log_a m + \log_a n$.

If the number of persons born in a certain country per annum be $\frac{1}{30}$ th of the population at the beginning of the year, and the number that die be $\frac{1}{40}$ th, find, by use of the logarithm tables, in how many years the population will be doubled.

9. Write down the expansions of a^x and $\log_e(1+x)$ in ascending powers of x , stating the limitations, if any, on the values of x , and show how to calculate the values of logarithms to base 10 by means of the expansion of $\log_e(1+x)$.

Find the value of $\log_e 3$ to three places of decimals.

10. Twenty persons are arranged at random in a straight line; show that the chance that four given persons, out of the twenty, shall be consecutive is $\frac{1}{285}$.

11. The chance of an event happening in any trial being known, find the chance of its happening at least r times in n trials.

From a pack of fifty-two playing cards four are drawn at random. Show that the odds against there being one of each suit lie between 8 to 1 and 9 to 1.

12. Prove the formula—

$$\Delta^n u_x = u_{x+n} - nu_{x+n-1} + \frac{n(n-1)}{1.2} u_{x+n-2} - \dots + (-1)^n u_x.$$

If all the terms, except u_5 , of the series u_1, u_2, \dots, u_9 be given, show that the value of u_5 is—

$$\frac{56(u_4 + u_6) - 28(u_3 + u_7) + 8(u_2 + u_8) - (u_1 + u_9)}{70}.$$

Second Paper.

13. A man buys a certain number of eggs at 11 a shilling, and three times as many at 15 a shilling; he mixes them and sells them at 13 a shilling; how much does he gain or lose per-cent?

14. Write down any sum of money consisting of any number of pounds, shillings, and pence, the number of pounds being greater than the number of pence, and the number of pounds less than

twelve. Subtract from it the sum obtained by interchanging the numbers of pounds and pence. To this result add the sum obtained by interchanging in it the numbers of pounds and pence. Show that the answer is always £12. 18s. 11d.

15. Show that a quadratic equation cannot have more than two roots.

Show that the roots of the equation $\frac{1}{x} + \frac{1}{x+a} + \frac{1}{x+b} = 0$ are real if $a^2 - ab + b^2$ is positive.

16. Find the n th term of an harmonical progression whose first two terms are a and b .

If a, b, c, d are four unequal quantities in harmonical progression, and if d, a, b, c are in proportion, prove that $3a + c = 0$.

17. Find the first four terms in the expansion of

$$(1+4x)^{\frac{1}{2}} \times (1-3x)^{-\frac{1}{2}}$$

in powers of x .

Find the coefficient of x^n in the expansion of $\frac{1-2x+3x^2}{(1-2x)^3}$.

18. Define the characteristic and mantissa of a logarithm, and show how the value of the former is determined for any number by inspection.

Making use of the tables, find the value, to two places of decimals, of—

$$\frac{(8.345)^3 \times \sqrt{7.89}}{(233)^{\frac{1}{2}} \div \sqrt[3]{469.6}}.$$

19. Sum the following series—

(1) $1^3 + 2^3 + 3^3 + \dots$ to n terms;

(2) $3 - 20x - 30x^2 - 290x^3 - \dots$ to infinity, where $x < \frac{1}{5}$, the series being a recurring one.

20. Given one solution in positive integers of the equation $ax + by = c$, find the general solution.

How can I divide 5 half-crowns, 6 florins, and 29 sixpences between two persons so that each person shall have the same amount of money and also the same number of coins?

21. Four men, A, B, C, D, throw with two dice whose faces are numbered 1, 2, 3, 4, 5, 6 respectively; the man who first throws 7 wins the stake; if they throw in the order A, B, C, D, and so on continually, what are their respective chances of winning?

22. If there are two independent events, the respective probabilities of which are known, find the probability that both will occur.

A makes a correct statement 3 times out of 4, and B makes

a correct statement 9 times out of 10, and they both assert that a ball drawn from a bag known to contain 10 balls, all of different colours, was white; find the chance that it really was white.

23. Find the value of $\Delta^n u_x$, when u_x is equal to—

$$(1) x^n;$$

$$(2) 1 \div [x(x+1)(x+2) \dots (x+m-1)].$$

24. Find the integral of an expression of the form—

$$u_x \cdot u_{x+1} \cdot u_{x+2} \dots u_{x+m-1},$$

where $u_x = ax + b$, a and b being constants.

Find by this method the sum of n terms of the series
 $1.4.7 + 4.7.10 + 7.10.13 + \dots$

EXAMINATION FOR ADMISSION TO THE CLASS OF ASSOCIATE (PART II).

Examiners—MESSRS. J. E. FARLKS, B.A., O. KENTISH, W. O. NASH,
and S. G. WARNER.

First Paper.

1. Deduce from first principles a formula for the amount of an annuity-certain for n years, payable by instalments k times a year, interest at the rate x being convertible m times a year.

2. The value and term of an annuity-certain being known, and a set of Interest Tables being available, deduce a formula, based on the Calculus of Finite Differences, to determine the rate of interest involved.

3. The "Life Table" of the Institute Text-Book contains columns headed as follows:

$$l_x \quad d_x \quad \mu_x \quad p_x \quad q_x \quad L_x \quad N'_x \quad T_x \quad e_x$$

Define each of these symbols and write down equations expressing the relation of each function to l_x .

In a certain community the number of annual births has been observed to decrease approximately in a Geometrical Progression. It is desired to introduce a pension scheme, pensions to commence at age 65, the contributions being from age 20 to age 55. The number of births this year being k , find expressions for the immediate numbers of pensioners and contributors.

4. State the principles underlying the laws of mortality known by the names of Gompertz and Makeham. Give formulas for l_x and μ_x according to each law.

Explain clearly the properties of the two laws respectively with regard to the calculation of Joint Life Annuities, proving your statement with respect to Makeham's law.

5. Find, without using commutation symbols, a formula for the first premium (net) on an endowment assurance of 1 on a life now aged 30, payable on the 25th anniversary of the policy or at previous death; the premium to be limited to 10 annual payments and to increase by .0025 per annum.

6. Explain briefly the method of constructing Premium Conversion Tables.

In the construction of such a table for single premiums to three or more decimal places, the intervals in the value of a being .01, it will be found that, in cases of rates of interest commonly in use, the figures in the third and following decimal places will recur at intervals. Give a general proof of this statement and show how many values of A will be included in each of these cycles in a table calculated at $2\frac{3}{4}$ per-cent.

7. Write down an expression for the net premium payable by a husband aged 40, to provide an annuity of 1 to his wife aged 30, should she survive him; the premium to be payable quarterly in advance for a period not exceeding 20 years, and the annuity to commence at the death of the husband and to be payable quarterly with proportion to the death of the widow.

Reduce the expression to the form from which the numerical value can be most conveniently calculated.

8. Write down a formula for $A_{xy:z}^1$ in its lowest terms and show how the following expressions may be written in terms of A_{xyz}^1 and similar functions

$$A_{xy;z}^{\overline{3}} \quad A_{x;y:z}^1$$

Write down also the definite integrals corresponding to the three functions.

9. What is the single premium for a deferred annuity of 1 to (x) , commencing at age $x+n$, the premium to be returned on death before $x+n$, and, if death occur after that age and before the annuity-payments amount to the premium, the balance to be returned?

10. A policy of 1, effected for the whole term of life at age x , has been n years in force. Find the Free Policy which may be granted, in terms (i) of the net policy-value (ii) of net annual premiums.

Show what the expressions become, and prove their identity, in the case of a sinking fund policy, term t years, which has been n years in force.

11. Having available the returns of two censuses taken at an interval of 10 years, and the records of births and deaths for the intervening period, describe the method by which you would obtain the values of q_0, q_1, \dots, q_5 .

12. Describe in detail the process by which you would construct a complete table of A_{xy} from complete tables of A_x and A_{xy} .

13. State what is meant by a differential coefficient. Obtain an equation expressing the first differential coefficient of a function in terms of the differences of that function.

Investigate an expression for $\frac{d}{dx} \bar{a}_{x:\overline{n}|}$ and show what approximate conclusion this leads to on the assumption that Makeham's law holds.

Second Paper.

[A short collection of Actuarial Tables will be supplied, and should be used in answering Questions 14, 15, 18, 23 and 25.]

14. Deduce a formula for the amount of an annuity-certain for n years where interest is assumed to be at the rate i_1 for the first p years, i_2 for the second p years, &c., and i_m for the m th p years, where $mp=n$.

Find the annual premium for a sinking fund policy to mature in 40 years, where interest is assumed to commence at 4 per-cent and to decrease by one-half per-cent every 10 years.

15. Explain what is meant by an annuity of the r th order, and investigate an expression for its present value.

A 20-year sinking fund policy is effected on an increasing scale of premiums, beginning at £100 per annum and rising by £3 each year till the end of the term. At the end of the fourth year it is proposed to commute further payments. Determine their value on a 3 per-cent basis.

16. Explain what is meant by the symbol $Q_{x:y(\overline{r})}^1$. Find a formula for it, reducing your result to its lowest terms.

17. Give two verbal interpretations of the formula $P_x = \frac{1}{1+a_x} - d$.

18. Deduce a formula for a reversionary annuity to (x) after the death of (y) , the annuity to continue in any event for 20 years from the death of (y) .

Find by the Text-Book Table at 3 per-cent interest the annual premium for such a benefit when $x=25$ and $y=60$.

19. Obtain a formula for the office annual premium, P , required for a policy on (x) for a term of n years, the assurance to cover (i) an advance of £ p made out of a trust fund at the beginning of each year, (ii) the premiums actually paid under the policy, (iii) the legal costs of the arrangement, say £ a . [Assume that $P=\pi(1+k)+c$].

20. An estate worth £ a per annum is held on lease at an annual rent of £ $(a-b)$ until the death of the survivor of three lives, aged x , y , and z , respectively. It is desired to make the lease perpetual, the tenant paying a Fine at each death and substituting a new life. Deduce a formula for the amount of the Fine.

21. Show, symbolically and by general reasoning, the relation between ${}_nV_x^{(m)}$ and ${}_nV_x$.

22. A fund is settled on A for life, with remainder to B for life, with remainder to C absolutely. Define the respective interests of A, B, and C, and give an expression for the value of each.

23. Write down formulas, with and without commutation symbols, for the annual premium for a joint-life term policy.

Calculate the annual premium for a three-year term policy on the joint lives of A and B, each aged 36 next birthday, at 3 per-cent interest, having given

$$\log l_{36} = 5.9097$$

$$\log l_{37} = 5.9076$$

$$\log l_{38} = 5.9042$$

$$\log l_{39} = 5.9002$$

How would you approximate to such a premium in practice?

24. Explain the nature of the error introduced by assuming that

$$q_x = \frac{d_{x-\frac{1}{2}} + d_{x+\frac{1}{2}}}{E_{x-\frac{1}{2}} + E_{x+\frac{1}{2}}}$$

25. State Maclaurin's theorem and show briefly how the following formula may be derived therefrom:

$$\int_0^{\infty} u_x dx = n \{ .28u_0 + 1.62u_n + 2.2u_{3n} + 1.62u_{5n} + .56u_{6n} + 1.62u_{7n} \}.$$

Apply the formula to find by the Text-Book Tables the value at 3 per-cent interest of $\bar{a}_{51:47}$.

EXAMINATION FOR ADMISSION TO THE CLASS OF FELLOW (PART III, SECTION A).

Examiners—MESSRS. H. W. ANDRAS, L. F. HOVIL, W. HUGHES, G. MARKS,
W. P. PHELPS, M.A., and G. TODD, M.A.

First Paper.

1. What is meant by the rule against perpetuities?

The creation of an estate-tail apparently infringes the rule: show that it does not really do so.

2. A trustee invests part of the trust estate in the purchase at a premium of stock, repayable at par at a fixed future date, and part of the estate consists of leasehold house property. In the absence of express instructions in the deed or will constituting the trust, how much of the dividends and rents is the tenant for life entitled to claim?

3. What are the duties and obligations imposed on a Friendly Society on registration?

4. Give some account of the New York Money Market and the course of the exchange between the United States and this country. What are the leading items in the account forming the "balance of Trade" between the two countries?

5. In connection with the South African War large sums have been raised for the necessary expenses incurred thereby. State what methods were open to the Chancellor of the Exchequer, and criticise the means actually adopted.

6. Give a short account of the constitution of the Bank of England.

Under what circumstances would the Government suspend the Bank Act of 1844?

7. What data would you require and how would you apply the "nearest duration" method of obtaining the "exposed to risk" at any age from the statistics of a Life Assurance Company for a given period in connection with the formation of an aggregate Mortality Table from the mortality experienced under ordinary whole-life policies?

8. Enumerate shortly the advantages and disadvantages of three of the principal methods adopted for the graduation of mortality tables. To what tables have the methods you mention been applied?

9. Describe briefly the mode of construction of Sprague's Select Mortality Table.

10. Find a general expression for the function u_x , given n consecutive equi-distant values of the function, and assuming it to be rational and integral of the $(n-1)$ th degree.

$$\begin{aligned}\text{Given} \quad a_{50} &= 13.87828 \\ a_{51} &= 13.52286 \\ a_{52} &= 13.16439 \\ a_{53} &= 12.80283\end{aligned}$$

find the approximate value of $a_{50\frac{1}{2}}$.

11. Integrate the factorial expression $\frac{1}{u_x u_{x+1} \dots u_{x+m-1}}$, where $u_x = ax + b$, and find the sum of n terms of the series

$$\frac{1}{3.7.11} + \frac{1}{7.11.15} + \frac{1}{11.15.19} \dots$$

12. Prove that if $\phi_{(x)}$ be a rational and integral function of x of the n th degree, its n th difference will be constant, and show that

$$\Delta P_x = \frac{P_x}{a_x} - \frac{C_x}{N_x}.$$

Second Paper.

13. State shortly the present legal position of a purchaser for value from the assignee under a voluntary settlement, in the event of the subsequent bankruptcy of the settlor, and refer to the recent cases that have dealt with this point.

14. Explain the position of Life Companies as regards the payment of claims under policies in cases where the life assured has disappeared.

15. What are the chief provisions of the Companies Act, 1900, and how, if at all, do they affect Life Assurance Companies?

16. State the arguments for and against efforts to repay or materially reduce the National Debt. What are the means in force, or temporarily suspended, having that end in view?

17. To what causes do you attribute the rise in the rate of interest yielded by first-class securities during the past two years?

18. Explain how variations in the rate of interest in London affect the flow of bills to this country.

19. What data would you require and how would you proceed to construct a Mortality Table from the Census statistics of a large population?

What corrections would you make for probable errors in the Census returns, and how would you graduate the Table?

20. Describe the principal methods of arranging the data for the purpose of extracting the mortality experience of a body of assured lives, and illustrate your remarks by reference to well-known tables.

Write down the formula for the exposed to risk under each of the methods you mention.

21. Give a specimen card for recording the data required for deducing the sickness experience of a large Friendly Society for five years.

The Society grants sick benefits at full-pay during the first six months' sickness, half-pay during the second six months, and quarter-pay thereafter.

How would you obtain the unadjusted rates of sickness, and how would you adjust them?

22. What important experience dealing with the Sickness of Female members of Friendly Societies has been published? In what form is the Experience tabulated, and from what data was it derived?

What statistics should in your opinion be required in order to show the special features of Female Sickness experience as compared with that of Males?

23. Explain the necessity of a constant in general expressions for the integration of functions of x , and its disappearance in the case of finite integration.

Prove that—

$$u_x + u_{x+1} + \dots + u_{x+n-1} = nu_x + \frac{n(n-1)}{1.2} \Delta u_x + \frac{n(n-1)(n-2)}{1.2.3} \Delta^2 u_x + \&c.$$

and apply it to sum the first 20 terms of the series whose general term is $n^2 + 5n$.

24. Prove that—

$$\Delta^n u_x = u_{x+n} - nu_{x+n-1} + \frac{n(n-1)}{1.2} u_{x+n-2} + \dots + (-1)^n u_x$$

and deduce

$$\Delta^n o^m = n^m - n(n-1)^m + \frac{n(n-1)(n-2)^m}{1.2} - \&c.$$

EXAMINATION FOR ADMISSION TO THE CLASS OF FELLOW (PART III, SECTION B).

Examiners—MESSRS. H. W. ANDRAS, L. F. HOVIL, W. HUGHES, G. MARKS,
W. P. PHELPS, M.A., and G. TODD, M.A.

First Paper.

1. Describe in detail Mr. Lidstone's method of valuing Endowment Assurances in groups.

What precautions should be observed in its practical application?

How far is the method applicable to the valuation of other forms of assurance?

2. A Life Assurance Office proposes to lower its valuation rate of interest. Draft a skeleton report to the Board of Directors mentioning all the points which should be considered before arriving at a decision.

How would you calculate approximately the resulting increase in the reserves?

3. A British Life Office with a considerable Indian business has a number of Rupee policies on its books. The premiums and the sums assured are payable in India in rupees, and the liability ascertained at each valuation is expressed in sterling at the Exchange of the day, and brought into the accounts in that form. What would be the effect of fluctuations in the value of the rupee on the financial position of the Office?

What practical methods of guarding against such fluctuations suggest themselves to you?

4. What are your views as to the desirability of a Life Office purchasing or lending on reversions to leasehold property?

Value the absolute reversion on the death of a male aged 60 to Leasehold house property in the City of London producing a net rental of £2,000 per annum, and held for 50 years unexpired at a ground rent of £500 per annum.

5. What preliminary enquiries would you consider necessary before entertaining an application for a loan to a Local Authority?

6. An Assurance Company has invested in a number of securities at a premium, repayable at par, some by annual drawings and some at fixed future dates. How would you deal with them in the Company's books?

7. How are Life Assurance Offices assessed for Income Tax, and what alterations, if any, would you suggest in the mode of assessment?

8. Draft a Report to the Board of Directors of a Life Assurance Company, showing whether the results of a particular Branch Office in a provincial district have been favourable or otherwise, with special reference to the strain of expenditure.

9. What legal requirements have to be satisfied on an amalgamation between two Life Offices?

In the case of a Proprietary Office which has decided on amalgamating it is found that its Stock Exchange securities have for many years been considerably under-valued in its accounts. How would you determine who has suffered by this practice, and how would you advise the Directors to deal with the latent surplus now disclosed, in order that it may be equitably apportioned among those entitled to it?

10. On what bases as to mortality, interest, and loading, would you calculate a table of premiums for with-profit policies on the lives of children, the assurance and participation in profits being deferred till age 21, and premiums being returnable in the event of death under that age? Write down the formula for the Office annual premium.

11. Assuming Makeham's formula for the law of mortality, deduce, by the aid of the integral calculus, a formula for the value of \bar{A}_{xy}^1 .

12. u_x , u_{x+1} , and u_{x+2} , are the tabulated values of the logarithms of three successive numbers x , $x+1$, and $x+2$, and differ from the true values by a small quantity; the logarithm of $x+t$ is derived from these tabulated values by interpolating to second differences.

If the errors in the tabulated values are a , $-b$ and c respectively, show that the error in the derived value will be least

when $t = \frac{1}{2} \frac{3a + 4b + c}{a + 2b + c}$, and that the amount of such error will then be $a - \frac{(3a + 4b + c)^2}{8(a + 2b + c)}$ exclusive of any error arising from third and higher differences being neglected.

Second Paper.

13. An Office has on its books a large number of policies originally issued as ordinary whole-life participating policies, but converted into Endowment Assurances by application of past bonuses. How would you value such policies, and allot the new bonuses to them at a quinquennial valuation?

14. A Life Assurance Company making net premium valuations on the Institute of Actuaries H^M Table at $2\frac{1}{2}$ per-cent interest has on its books a large number of "discounted bonus" policies. How should such policies be valued, and how would you state the results in the "summary and valuation" forms of the Fifth Schedule of the Board of Trade Returns?

15. You are asked to make a valuation of the liabilities of an old-established provident fund which grants the following benefits:

- (a) Sick benefits and pensions on permanent disablement;
- (b) Pensions to widows of deceased members during widowhood;
- (c) Allowances for children of deceased members until the age of 14.

For what particulars would you ask in order to make your valuation, and how would you determine the bases on which that valuation should be made?

16. Discuss, from the point of view of a Life Office, the relative merits of (a) purchasing Stock Exchange Securities and other forms of property and (b) lending on Mortgage. Do you think that the amount of any single mortgage should be limited, and if so, for what reasons?

17. In considering proposals for Mortgages on Life Interests, either in possession or reversion, how would you arrive at the amount of net income you would take as available to meet the Annual Charges under the mortgage when the income of the life tenant is derived from funds invested in:—

- (a) Stock Exchange Securities of the highest class.
- (b) Stock Exchange Securities yielding relatively high rates of interest.
- (c) Mortgages on freehold property.
- (d) Freehold house property.

18. Draft an Annuity Class Book giving the particulars required for valuation purposes and for the calculation of the annual gain or loss from mortality in a convenient form for practical use.

19. A Life Office purchases a reversionary life interest arising out of an estate of ample value.

How would you treat the investment in the annual accounts, and at the periodical valuations (*a*) during the lifetime of the tenant for life and (*b*) after his death?

What considerations would influence you in determining the price at which the interest might be re-sold to the reversioner on the death of the tenant for life?

20. What loan would you advise should be granted and at what rate of interest on security of a life interest in the following fund:—

£10,000 Consols.

10,000 India $3\frac{1}{2}$ per-cent Stock.

10,000 Midland Ry. $2\frac{1}{2}$ per-cent Debenture Stock.

The Tenant for life is aged 30 next birthday, and there is in force and available for inclusion in the security a whole-life with-profit policy for £5,000 taken out 10 years ago, amounting, with reversionary bonus since added, to £5,750, the annual premium being £100?

21. A, aged 80, B, aged 50, and C, aged 25, father, son, and grandson, are life tenant and successive reversioners in an estate-tail. B and C wish jointly to raise money by the sale of a reversionary annual charge to take effect on the death of A. B is uninsurable; C is assurable at ordinary rates. State how you would deal with the case, and deduce the formulæ you would use in calculating the annual reversionary charge for a present payment, and the amount required to redeem such charge.

22. Three partners, A, B and C, aged respectively 30, 35 and 40, possess a capital of £10,000, and their proportionate interests in the business are 2, 3, and 5 tenths. How would you calculate the premium for an assurance to cover the risk of having to pay out the representatives of the partners who may happen to die first and second?

23. Prove that—

$$\mu_{xyz} = \mu_x + \mu_y + \mu_z$$

and write down its value in terms of the constants involved in Makeham's formula expressive of the law of human mortality.

24. Explain the meanings of the functions—

$$\bar{a}_{yz|wx}^2, \quad \bar{a}_{xyz|w}^3, \quad \text{and} \quad \bar{A}_{wxyz}^4$$

and write down the integrals expressing their values.

PROCEEDINGS OF THE INSTITUTE.—SESSION 1900–1901.

First Ordinary Meeting, 26 November 1900.

The first ordinary meeting of the Session 1900–1901 was held at the Hall of the Institute, on the 26th day of November 1900.

The President (Mr. C. D. HIGHAM) in the Chair.

The President announced that Mr. George Macritchie Low had been unanimously elected a Member of Council to fill the vacancy on the Council caused by the death of the late Mr. A. J. Finlaison, C.B.

It was reported that four essays on “The Actuarial Aspects of Recent Legislation in the United Kingdom and Other Countries on the subject of Compensation to Workmen for Accidents” had been sent in to compete for the prizes offered out of the fund presented to the Institute by the late Mr. Samuel Brown, and that a prize of the value of forty guineas had been awarded to Mr. John Nicoll, A.I.A., F.F.A. The second prize was not awarded, no one of the other three essays being considered of sufficient merit.

The President delivered an inaugural address.

Second Ordinary Meeting, 31 December 1900.

The President (Mr. C. D. HIGHAM) in the Chair.

Mr. James Watt, F.F.A., was duly elected an Associate, and Mons. Julius Altenburger was also duly elected a Corresponding Member of the Institute.

The essay on “The Rationale of Discounted Bonus Premiums”, to which a prize, presented by Mr. James Chisholm, had been awarded, was read in abstract by the author, Mr. Henry Moir.

The following gentlemen took part in the discussion:—Messrs. W. Hutton, J. Sorley, G. King, H. E. W. Lutt, H. W. Manly, S. G. Warner, F. Bell, and J. Chisholm.

The President announced that arrangements had been made for the delivery of a course of Lectures on the Law of Mortgage, by Mr. W. G. Hayter, during the current session.

Third Ordinary Meeting, 28 January 1901.

The President (Mr. C. D. HIGHAM) in the Chair.

The President (all rising and standing while he spoke), referred to the loss the country had sustained by the death of Her late Majesty, expressing also the Institute's sympathy and loyalty.

A paper entitled “The Effect of using the Lapse Element in calculating Premiums and Reserves”, by Mr. Arthur Hunter, of New York, was read in abstract by Mr. Woods (Hon. Secretary).

The following gentlemen took part in the discussion:—Messrs. H. M. Trouncer, R. P. Hardy, P. Gibson, G. King, F. Bell, T. G. Ackland, J. Holliday, H. W. Manly, and Stanley Day.

Fourth Ordinary Meeting, 25 February 1901.

The President (Mr. C. D. HIGHAM) in the Chair.

A paper entitled “The Increase of Cancer”, by Mr. R. Teece, of Sydney, N.S.W., was read in abstract by Mr. Woods (Hon. Secretary).

The following gentlemen took part in the discussion:—Messrs. G. King, T. G. Lyon, R. P. Hardy, and H. W. Manly; also Sir Thomas Smith, and Drs. Hingston Fox, Payne, and Newsholme (visitors).

Fifth Ordinary Meeting, 25 March 1901.

The President (Mr. C. D. HIGHAM) in the Chair.

All present standing, the President read a message from H.M. the King, acknowledging the Address of the President, Council, and Members of the Institute of Actuaries, expressing their sympathy on the occasion of the lamented death of Her late Majesty Queen Victoria, and congratulation on His Majesty's accession to the throne.

A paper entitled "On the Rates of Mortality in New South Wales and Victoria, and the construction of a Mortality Table from a single Census and the Deaths in the years adjacent thereto", by Messrs. E. M. Moors and W. R. Day, of Sydney, N.S.W., was read in abstract by Mr. Woods (Hon. Secretary).

The following gentlemen took part in the discussion:—Messrs. H. J. Baker, L. F. Hovil, R. P. Hardy, H. W. Manly, H. P. Calderon, C. H. E. Rea, and J. E. Faulks; and Mr. J. Fitzsimons (a visitor).

Sixth Ordinary Meeting, 29 April 1901.

The President (Mr. C. D. HIGHAM) in the Chair.

A paper entitled "On the Valuation of Staff Pension Funds; with Tables and Examples", by Messrs. H. W. Manly and E. C. Thomas, was read in abstract by the authors.

The following gentlemen took part in the discussion:—Messrs. A. D. Besant, G. J. Lidstone, P. L. Newman, A. Hewat, T. G. Ackland, and R. P. Hardy.

The Fifty-fourth Annual General Meeting, 3 June 1901.

The President (Mr. C. D. HIGHAM) in the Chair.

The proceedings at the Annual General Meeting will be found on page 313.

REPORT, 1900-1901.

The Institute has already laid at the foot of the throne its address of sympathy and loyalty, but the Council cannot begin their customary Report without another reference to the country's loss in the death of the beloved Lady who for so long bore rule over a vast realm. That wonderful reign was marked by a wide-spreading splendour, but the immense progress made in economic science, and with many enterprises for the good of the people, will always constitute one of its chief claims to perpetual remembrance, and it is gratifying to recollect that the Institute had its birth in the Victorian Age.

During the year ending 31 March, 1901, the fifty-third of the Institute's existence, there has been a *decrease* of 4 in the number of members, as compared with the previous year. Under the new rules for admission, 86 candidates have been admitted as Probationers; and 49 as Students conditionally on their passing Part I of the Examination, some of whom will, no doubt, have qualified themselves by passing the requisite examination in April. At the end of the official year in which the Institute was incorporated by the Royal Charter the number of members was 434,

while ten years later, at 31 March 1895, it was 775. Since that time the numbers have been as follows:

On 31 March 1896,	788,
„ 1897,	826,
„ 1898,	860,
„ 1899,	834,
„ 1900,	822,
„ 1901,	818.

The following schedule shows the additions, changes, and losses in the membership, which have occurred during the year ending 31 March last.

Schedule of Membership, 31 March 1901.

	Honorary Members	Fellows	Associates	Students	Corres- ponding Members	Total
i. Number of Members in each class on 31 March 1900 .	1	206	259	339	17	822
ii. Withdrawals by						
(1) Death . . . .	...	4	1	1	...	49
(2) Resignation . .	...	3	5	25	...	
(3) Default in pay- ment of Sub- scriptions . . .	...	...	2	8	...	
	1	199	251	305	17	773
iii. Additions to Membership						
(1) By Election . .	...	...	1	...	1	45
(2) By Order of Council	...	...	...	41	...	
(3) By Re-instatement	...	...	...	2	...	
iv. Transfers	1	199	252	348	18	818
(1) By Examination:						
from Associates	...	...	4	...	...	...
to Fellows . . .	...	4	...	...	...	...
	1	203	248	348	18	818
(2) By Examination:						
from Students	...	...	...	1	...	...
to Fellows . . .	...	1	...	...	...	...
	1	204	248	347	18	818
(3) By Examination:						
from Students	...	...	...	23	...	...
to Associates . .	...	...	23	...	...	...
v. Number of Members in each class on 31 March 1901 .	1	204	271	324	18	818

The Council have, with great regret, to report the loss by death of six Fellows, namely, Messrs. Alex. J. Finlaison, C.B., H. W. Porter, G. Cutchiffe, J. W. Stephenson, L. M. Simon, and D. McL. Slater; one Associate, Mr. E. Smyth; one Student, Mr. A. T. Heslop; and one Corresponding member, Monsr. H. F. G. Adan.

Mr. Finlaison became a Fellow of the Institute by examination in 1864, was elected to the Council for the first time in 1875, and served thereon for nearly 23 years. He was an Hon. Secretary in 1883 and 1884, Vice-President in 1887-1889, and President in 1894 and 1895. He succeeded his father and grandfather as Actuary to the Commissioners for the Reduction

of the National Debt, and his name will ever be connected with the Government Annuity Experience, 1883, which was compiled under his direction. He served on several Royal Commissions, and in 1886 was sent to Egypt to advise on financial matters. In 1887 he was created a Companion of the Bath.

Mr. Porter submitted himself to the first examination held by the Institute, and became a Fellow in 1850. He was elected to the Council in 1864, and served thereon for 20 years. He was a Vice-President in 1873-1875, and was a frequent contributor on various subjects to the *Journal*. To the last he took a deep interest in all that concerned the Institute, and bequeathed to the Library a number of valuable actuarial works.

Mr. Cutcliffe was elected an Associate in 1850, and a Fellow in 1864. He was on the Council for 16 years, serving as Treasurer for 12 years from 1866, and as a Vice-President in 1878-1881.

Mr. Stephenson was well known as an Actuary of the older school, and was one of the links between the present and other times. His skill and discoveries as to the construction and use of the microscope had gained him a world-wide reputation.

Mr. Simon was of a younger generation, but few had more endeared themselves to their colleagues than he. Not strong in health, he had yet served as an examiner and on the Council, though he was not able to be so closely identified with our affairs as others.

Mr. Slater had been a Fellow since 1873, but his official position compelling him to reside in India prevented his taking any active part in the work of the Institute.

In M. Adan, President of the Association des Actuaires Belges, the Institute has lost a corresponding member who, in the Brussels Congress of 1895, and by his paper to the Congress at London in 1898, added the respect of English actuaries to the high reputation he bore in his native land.

The vacancy on the Council caused by the death of Mr. Finlaison, was filled up in the prescribed manner by the election of Mr. George Macritchie Low.

The following papers were submitted at the sessional meetings of the Institute, namely :

- 26 *November* 1900.—An Inaugural Address by the President, Mr. C. D. Higham.
- 31 *December* 1900.—“On the Rationale of Discounted Bonus Premiums,” being the Essay by Mr. Henry Moir, to which a Prize was awarded from the balance of the Chisholm Prize Fund.
- 28 *January* 1901.—“The Effect of using the Lapse Element in calculating Premiums and Reserves”—Mr. Arthur Hunter.
- 25 *February* 1901.—“On the Increase of Cancer”—Mr. R. Teece.
- 25 *March* 1901.—“On the Rates of Mortality in New South Wales and Victoria, and the construction of a Mortality Table from a Single Census and the Deaths in the years adjacent thereto”—Messrs. E. M. Moors and W. R. Day.
- 29 *April* 1901.—“On the Valuation of Staff Pension Funds”—Mr. H. W. Manly: with Tables and Examples—Mr. E. C. Thomas.

For the Examinations held in the United Kingdom on 19, 20, 22 and 23 April last, 179 candidates presented themselves, namely :

65	for Part	I.
55	„ „	II.
37	„ „	III, Section A.
22	„ „	III, „ B.

Of these the following numbers were successful:

34	in Part	I.
9	„ „	II.
12	„ „	III, Section A.
14	„ „	III, „ B.

The following are the successful candidates, the names in each class being arranged alphabetically.

PART I.

Examiner—PROF. S. L. LONEY, M.A.

Supervisors—MESSRS. B. A. BERRY, B.A., and G. J. LIDSTONE.

Class I:

Downes, S. C.	Humphreys, H. T.
Gemmill, W.	Leigh, S. G.
Robertson, A. W. L.	

Class II:

Beddall, H. M.	Harper, H.
Bishop, H. G.	Hilary, H. J.
Blake, F. S.	Macmillan, A.
Bree, J.	Melville, H. E.
Caldwell, R. H.	Papworth, F. W.
Dent, E. E.	Spurgeon, E. F.
Elderton, M. B.	Steffensen, J. F.
Tregaskis, G.	

Class III:

Atkins, L. G.	Petter, H.
Brierley, W. E.	Ramsay, C. B.
Carter, G. S.	Rountree, A. F.
Clarke, E. E.	Sutcliffe, C. E.
Cockerton, J. L.	Todhunter, J.
Eggleton, H. E.	Wilton, H. G.
Felder, W. C.	Wood, R. S.

PART II.

Examiners—MESSRS. J. E. FAULKS, B.A., OWEN KENTISH,
W. O. NASH, and S. G. WARNER.

Class I:

None.

Class II:

None.

Class III:

Ashton, W. R.
Buckler, W. P.
Court, A. G. D.
Cross, H. T.

Culley, A. B.
Jarman, W. R.
Neill, S. B.
Penman W.

Rhodes, F.

PART III.

Examiners—MESSRS. H. W. ANDRAS, L. F. HOVIL, W. HUGHES,
GEOFFREY MARKS, W. P. PHELPS, M.A., and GEO. TODD, M.A.

SECTION A.

Class I:

None.

Class II:

Butterfield, W. T.

Class III:

†Brown, Hugh W.
†Buchanan, J.
Collins, F. L.
†*Dunn, S. G.
†Elderton, W. P.
Gillies, G.
†Gordon-Smith, R.
Kenchington, C. W.
May, B.
†Norton, W. E.
Richmond, G. W.

SECTION B.

Class I:

None.

Class II:

†*Dunn, S. G.
†Moorhouse, A.
†Searle, G. M.

Class III:

†Adlard, H. T.
Anderson, T. F.
Appleton, F.
†Austin, H. H.
Galer, F. B.
†Macphail, D.
†Reeve, C. E.
†Sharman, W. C.
Strong, W. R.
Tinner, T.
Woolhner, A. H.

Those marked (†) have now completed the examination for the Class of Fellow.
(*) Mr. Dunn passed in both sections.

In the Colonies the Examination entries numbered 65, as under:

31 for Part I.
25 II.
6 III, Section A.
3 III, .. B.

The results of the Colonial Examinations will be duly announced. §

§ These results are given on page 321.

The Council warmly acknowledge the valuable services of the Honorary Examiners.

The Third International Congress of Actuaries was held in Paris on 25-30 June 1900, under the presidency of Monsieur Paul Guieysse, formerly Minister for the Colonies, and President of the Institut des Actuaire Français. Monsieur Millerand, the Minister of Commerce, was the Président d'honneur, and, besides presiding at one of the meetings, held a reception at his official residence at which the members of the Congress were welcomed. The delegates of the Institute were Messrs. C. D. Higham, Manly, Ryan, Wyatt, Chisholm, BurrIDGE, H. Cockburn, E. Woods, and Schooling. The Procès-verbaux Sommaires have already been issued, and the Transactions are in course of being printed under the able supervision of Monsieur Léon Marie, Secretary of the Congress, as well as Secretary-General of the French Institute of Actuaries.

A prize of the value of forty guineas, being the first of two prizes offered out of the Fund presented to the Institute by the late Mr. Samuel Brown, has been awarded to Mr. John Nicoll, A.I.A., F.F.A. (who won, three years ago, one of Mr. Chisholm's prizes), for his essay on "The Actuarial Aspects of recent Legislation in the United Kingdom and other countries on the subject of Compensation to Workmen for Accidents." The second prize was not awarded, no one of the other three essays being considered of sufficient merit.

Part I of the *Text-Book* has been re-written by Mr. R. Todhunter, and will be published almost immediately. A new edition of Part II, by Mr. George King, is in the hands of the printer. The best thanks of the Members will be given to both these gentlemen for the time and labour they have devoted to their difficult tasks.

The Card Index to the *Journal* for use in the Hall of the Institute, referred to in the last Annual Report, is practically complete and will be kept up to date.

During the session six excellent lectures on the Law of Mortgage were delivered in Staple Inn Hall by Mr. William Goodenough Hayter, Barrister-at-Law. These have been printed and will shortly be published.

The Council had much satisfaction in publishing in the last number of the *Journal* the correspondence which has taken place with Mr. Wallace, the Secretary of the Estate Duty Department; and with Colonel Young, the Secretary to the Royal Commission of the Patriotic Fund. The Council feel that their action in each case will meet with the hearty approval of the profession.

As regards the Mortality Investigation, jointly undertaken by the Institute of Actuaries and the Faculty of Actuaries in Scotland, the Council have to report that two further volumes setting forth the Unadjusted Data have been published during the year and issued to the contributing Offices, and the cards have been returned to their owners. The four volumes now published complete the tabulation of the Unadjusted Data, and comprise (1) Life Annuities—Males and Females; (2) Whole Life Assurances—Males; (3) Endowment Assurances and Minor Classes of Assurances—Males and Females; (4) Whole Life Assurances—Females. The tables (1) and (2) have been graduated with great skill by Mr. G. F. Hardy.

The computation of monetary values, based upon the Mortality Table for Annuitants, is proceeding in Scotland, under the direction of

Mr. Meikle and Mr. Chatham. Monetary values based upon the Mortality Table for Whole Life Participating Assurances—Males, are being computed by a London Staff, under the direction of Mr. T. G. Ackland. In response to a general desire, the values of Life Annuities for both sexes, computed, as at date of purchase, at $2\frac{1}{2}$, 3, and $3\frac{1}{2}$ per cent., have been printed and issued in advance to contributing Offices. It is proposed similarly to issue at an early date the graduated Mortality Table for Whole Life Participating Assurances—Males, with monetary values at 3 per-cent.

The accounts for the year show that the total funds on 31 March last amounted to £8,187. 3s. 7d., being an increase during the year of £762. 5s. 7d.

The Annual Subscriptions, together with admission and other fees, amounted to £1,768. 4s., showing a slight increase as compared with those of the previous year. The total Income for the year was £2,410. 8s. 1d., and the total Expenditure £1,648. 2s. 6d. The Revenue Account and Balance Sheet are given herewith (p. 312).

The stock in hand of the Institute publications on 31 March was as follows :

No. of Copies	Description of Work
48	<i>Text-Book</i> , Part II.
738	Government Joint-Life Annuity Tables.
812	Select Life Tables.
705	A Short Collection of Actuarial Tables.
142	Logarithm Cards.
300	Messenger Prize Essay (Friendly Societies).
37 in cloth } . . .	{ Lectures on Finance and Law (Clare and
3,060 in paper } . . .	{ Wood Hill).
1,752	Lectures on the Companies Acts (A. C. Clauson).
899	Proceedings of the Second International Congress of Actuaries.
10,922	Parts of <i>Journal</i> .
513	Index to Vols. 1 to 10.
1,007	„ to Vols. 21 to 30.

Amount of Funds at the beginning of the year—	£	s.	d.	£	s.	d.
General Fund	6,792	2	9			
Messenger Legacy Fund	341	15	2			
Brown Prize Fund	266	0	1			
Chisholm Prize Fund	25	0	0			
Subscriptions—				7,424	18	0
Followers	551	5	0			
Associates	560	17	0			
Students	324	9	0			
Probationers	49	17	6			
One Annual Subscription Compounded for				1,426	8	6
Application Fees—				10	10	0
Associates	2	2	0			
Students	33	12	0			
Probationers	26	15	6			
Examination Fees				62	9	6
				268	16	0
Sales of Publications—						
Journal	135	1	6			
Text Book, Part II	125	10	0			
Government Annuity Tables	7	18	8			
Selected Life Tables	8	9	0			
Short Collection of Actuarial Tables	3	14	5			
Barley's Friendly Societies	1	5	8			
Legal and Financial Lectures	5	6	0			
Logarithm Cards	2	5	8			
Transactions of Second International Congress	128	15	0			
Dividends and Interest (less tax)				418	5	11
				222	18	2
				£9,835	6	1

Balance Sheet, 31 March 1901.

LIABILITIES.	£	s.	d.	£	s.	d.
General Fund				7,606	16	4
Messenger Legacy Fund				233	9	2
Accumulated Dividends				115	6	0
Brown Prize Fund				348	15	2
Accumulated Dividends				200	0	0
				31	12	1
				231	12	1
				£8,187	3	7

Journal	£	s.	d.	£	s.	d.
Printing of Nos. 197, 198, 199, and 200				416	6	11
Clerical assistance				27	0	0
Expenditure on account of Card Index				25	2	6
Library—binding and purchases				468	9	5
				27	15	6
Brown Prize Award				42	0	0
Chisholm Prize Awards				25	0	0
Reprint of Text Book, Part II				29	7	6
Expenditure on account of New Editions of the Text Books				19	9	6
Meetings				38	19	8
Examination charges				62	13	7
Lecturers for classes in Parts I and II				52	10	0
Lectures on Law of Mortgage				24	15	0
Legal charges				4	9	8
Office Expenditure—						
Rent				275	0	0
Salaries				339	4	6
House expenses				49	7	4
Corporation Duty				10	1	6
Fire Insurance				14	4	6
Stationery and Printing				116	5	10
Postage and Telegrams				33	19	1
Furniture				7	5	7
Sundries				7	4	4
				852	12	8
Amount of Funds at the end of the year, as per Balance Sheet				8,187	3	7
Examined and found correct, 22 April, 1901.						
A. MACRAY V. J. DELL L. K. PACHEN } Auditors.				£9,835	6	1

ASSETS.	£	s.	d.
Natal 3 per cent Inscribed Stock (£3,000), cost	2,846	6	0
Metropolitan Railway 4 per cent Debenture Stock (£1,050), cost	1,185	11	3
Great Eastern Railway 4 per cent Debenture Stock (£1,000), cost	1,203	14	9
Great Northern Railway Preferred Ordinary Stock (£1,000), cost	1,142	11	9
Great Western Railway 4 per cent Debenture Stock (£800), cost	1,258	12	5
Outstanding Subscriptions	77	14	0
Cash on Current Account	372	13	5
	£8,187	3	7

[The Institute also possesses certain copyrights
and stocks of publications (see p. 311).]

Examined and found correct, 22 April, 1901.

A. MACRAY

PROCEEDINGS AT THE ANNUAL GENERAL MEETING.

The Annual General Meeting of the members was held at Staple Inn Hall, on Monday, 3rd June, the President, Mr. C. D. Higham, in the chair.

The Report of the Council (given on p. 305) having been read,

The PRESIDENT, in moving the adoption of the report and accounts, said that, as was fitting, the report began with reference to the good and great Queen, whose loss they deplored; it spoke for itself, and no further words of his were necessary to declare their sorrow or prove its sincerity; but he took the opportunity of mentioning that the Institute had contributed 50 guineas to the Queen Victoria Memorial Fund, which would meet with the hearty approval of the members.

The number of members was about the same as last year, the slight difference showing that the Institute had not yet recovered its equilibrium after the great inrush that occurred subsequently to the granting of the charter. While it was desired that the Institute should include all who seriously took up the profession of actuary, there was no advantage in having their lists swelled with the names of mere *dilettanti* adherents or those who had other axes to grind: it was quality rather than quantity they looked for, and he thought the Institute was securing it. With regard to Part II. of the Examinations, it was disappointing that out of 55 entrants only 9 had passed, and the matter had received the serious consideration of the Council. Whether it was partly due to the change in the syllabus, or through larger numbers having passed in previous years and selected themselves out of the general body he did not know, but he was afraid the entrants were not quite up to the mark, and that was borne out by the examiners' statement, that it was not the more difficult questions in which the candidates had specially failed, but the comparatively easier ones.

With regard to the papers read during the year, he called attention to the great effort of his distinguished predecessor, who had added, as it were, another *Text-Book* to those already published by the Council. The discussions on the papers, with one exception, were better than usual, and it was proposed to continue for a time that somewhat modified procedure which seemed to have been successful.

Their educational work was being carried on as usual. The revised *Text-Books* were well on their way. Part I. had been entirely re-written by Mr. Todhunter, and would very shortly be issued. Part II. needed less alteration, but it had been brought up to date by Mr. King, and, as it was in the printer's hands, its appearance would not be a matter of a very long time. A successful course of lectures had been delivered during the year, and he thought those who heard them would agree that the lecturer had well met their requirements in giving enough information, and not too much—they were ready for publication. It had been suggested, and he thought it was a very good suggestion, that on another occasion a note should be taken of what he might almost call the examination of the lecturer held on each occasion by his hearers, and some, at any rate, of the questions and answers published, to throw further light on those parts of the subject which were especially difficult to those who heard the lectures.

Another Messenger prize had been advertised, and he hoped that as the subject was a popular one a large number of essays would be sent in. The Card Index to the *Journal*, which was mentioned in the last report, was nearly complete. The cards were all written, and very soon anyone who was studying any subject would be able to obtain from the Index references of the fullest character to any mention of the matter as to which he might wish to be informed. While busy in these various ways, the Council had not forgotten that the Institute was a public body. When some little difficulty arose between one or two actuaries and the Estate Duty Department, it was felt that it was the duty of the Institute to support the interests of the profession in any way possible. The Department was approached and interviews held with the heads, and he was glad to have an opportunity of saying that they had been received not merely with courtesy—they expected that—but with warm sympathy; the representations made were considered, and the communication sent which had been published in the *Journal*, Vol. XXXVI, p. 82, so that the whole matter had been put right. And they had remembered, too, that privilege connoted duty, and when they heard that the Patriotic Fund Commissioners had need of actuarial advice, it was considered that they who had not been able to give personal service in the field might do something for King and country by furnishing actuarial assistance to that body, and the offer they made was (to use the authorities' words) most cordially and gratefully accepted, and they were now busy with the work. Then he thought he might come to the *magnum opus* of the Institute and the Faculty, the Mortality Investigation which was approaching completion. The *Times* was right in saying that the work probably ranked as the most accurate and exhaustive statistical investigation which had ever been conducted. Looking back, he thought it was possible they had been over particular in one or two points, but they were anxious to err by excess rather than by defect, and if any mistakes had been made, at any rate they were all set down in black and white, and those who came after them would be able to profit by their experience. He took the opportunity of mentioning that the tables would be known as "The British Offices Life Tables, 1893," and for short it would be enough to simply say the O^M Table. Advance copies of some annuity values had been already issued to those contributing offices who desired them. The O^M and the O^M ⁽⁵⁾ 3 per cent rates were calculated and printed, and would be similarly issued very shortly, while the volume of a variety of other rates was in the printers' hands, and would not be long delayed. The report mentioned the immense services of Mr. Ackland and Mr. G. F. Hardy, and hardly anything he could say would exaggerate what those gentlemen had done. It was a very happy thing for the Institute that Mr. Ackland found himself with comparative leisure at the time he was wanted, and he had devoted a very considerable portion of that time to the demands of the Joint Committee. Mr. G. F. Hardy had brought his unrivalled mathematical skill into play in graduating the two tables mentioned. But while the report spoke of the work of those two gentlemen, they must not forget their indebtedness to the Chairman, Mr. R. P. Hardy, and Mr. Burridge, who, since the Committee was established, had been one of the secretaries, and whose tact and ability had never failed.

Mr. R. P. HARDY, in seconding the motion, said that of all the pleasing duties that had fallen to his lot to discharge for this Institute, there had been none more personally agreeable than that assigned to him on the present occasion, namely, to second the motion for the adoption of the report; for this report announced the completion of that important mortality investigation upon which, in most happy conjunction with their sister association, the Faculty of Actuaries, they had been engaged. They were all deeply indebted to the Committee who, at the cost of great personal inconvenience had given not only large slices of their valuable time, but also the unpurchaseable benefit of their laboriously acquired skill. And he said this more especially of their Edinburgh friends, who never thought the journey too far nor the demands too onerous to respond to the summons to meetings.

A statement, which he now submitted, had been prepared, giving certain figures comparing the New Tables of Mortality with those of the older Standards, and perhaps he might be permitted to indicate, very briefly, in what points the New Experience differed from the Old (1) as a general measure, and (2) in its particular application when combined with interest to that most important function, the Reserve.

As to the first, he would claim for the method selected for representing the difference that the facts appeared to stand out in graphic and suggestive clearness and to be exhibited in a state ready to sustain other deductions. Thus, if they took two equal populations of a common present and limiting age and each of them subject to the play of a different death rate, the number of survivors at each point of observation would indicate in a very concrete form the results of the forces in operation. Taking, for instance, entry age 30, the Statement showed that 219·1 deaths were accelerated, and the same number retarded, under the H^M Table—hence the difference between the respective single premiums must be merely the difference between the discounted values of the numbers accelerated and those retarded.

With respect to the second object in view, he was unable to suggest any better test than the actual figures of the Reserves; and accordingly the second table was set out in that form for the most important attained ages, namely, 55, 60, 65—and very instructive were the results.

In conclusion, he hoped that the members would, in adopting this motion, accord their votes, not only with unanimity of voice, but with acclamation, so that those of their brethren that had borne the burden of heavy work, now brought to so successful an issue, might feel that their labours were appreciated by those on whose behalf they were undertaken.

The motion was unanimously agreed to.

INSTITUTE OF ACTUARIES' AND FACULTY OF ACTUARIES' JOINT MORTALITY INVESTIGATION

BRITISH OFFICES EXPERIENCE (MALE PARTICIPATING ASSURANCES: 1893) COMPARED WITH
THAT OF H^M AND H^{M(5)}

Experience of 10,000 Entrants at each entry-age

Age Period	Entry-Age = 30										Entry-Age = 35										Entry-Age = 40										Age Period
	AGGREGATE EXPERIENCE					TRUNCATED EXPERIENCE					AGGREGATE EXPERIENCE					TRUNCATED EXPERIENCE					AGGREGATE EXPERIENCE					TRUNCATED EXPERIENCE					
	No. of Survivors at end of period		No. of H ^M Deaths		No. of H ^{M(5)} Deaths	No. of Survivors at end of period		No. of H ^M Deaths		No. of H ^{M(5)} Deaths	No. of Survivors at end of period		No. of H ^M Deaths		No. of H ^{M(5)} Deaths	No. of Survivors at end of period		No. of H ^M Deaths		No. of H ^{M(5)} Deaths	No. of Survivors at end of period		No. of H ^M Deaths		No. of H ^{M(5)} Deaths						
	H ^M	OM	Greater	Less		H ^M	OM	Greater	Less		H ^M	OM	Greater	Less		H ^M	OM	Greater	Less		H ^M	OM	Greater	Less		H ^M	OM	Greater	Less		
30-34	9,001-3,967-7		78-4	..	70-6	9,545-5,916-1		..	..	66-8	9,536-7,960-5		..	..	85-3	9,478-3,956-3		..	..	..	..	..	..	..	..	..	..	..	..	30-34
35-39	9,156-5,926-9		61-0	..	78-3	9,047-5,916-4		..	..	33-5	8,938-4,906-0		..	..	41-3	8,838-3,893-9		..	..	..	..	..	..	..	..	..	..	..	..	35-39
40-44	8,670-6,888-5		28-5	..	38-8	8,532-5,719-9		..	..	31-3	8,438-3,850-5		..	..	44-9	8,308-1,848-2		..	..	..	..	..	..	..	..	..	..	..	..	40-44
45-49	8,092-8,286-3		25-6	..	38-8	7,930-5,815-7		..	..	16-0	7,708-9,785-5		..	..	44-8	7,550-1,769-4		..	..	..	..	..	..	..	..	..	..	..	..	45-49
50-54	7,401-5,760-8		9-8	..	37-8	7,206-9,747-2		..	..	11-6	6,822-4,674-8		..	..	17-9	6,647-4,688-6		..	..	..	..	..	..	..	..	..	..	..	..	50-54
55-59	6,550-4,675-3		3-2	..	10-8	6,345-3,620-3		..	..	1-4	5,713-5,877-5		..	..	3-0	5,537-6,579-2		..	..	..	..	..	..	..	..	..	..	..	..	55-59
60-64	5,485-7,568-2		3-1	..	9-2	5,285-9,570-1		..	..	1-4	4,418-6,453-7		..	..	3-6	4,257-7,493-1		..	..	..	..	..	..	..	..	..	..	..	..	60-64
65-69	4,242-4,417-5		..	..	..	4,064-2,420-7		..	..	11-1	3,854-2,977-6		..	..	3-6	2,858-5,306-9		..	..	..	..	..	..	..	..	..	..	..	..	65-69
70-74	2,858-8,308-4		6-1	..	1-4	2,728-6,291-1		..	..	5-5	1,614-5,174-0		..	..	15-7	1,537-7,171-3		..	..	..	..	..	..	..	..	..	..	..	..	70-74
75-79	1,550-1,619-1		1-6	..	..	22-2	1,467-8,165-1		..	76-4	628-4,711-5		..	..	73-0	638-9,744-0		..	..	..	..	..	..	..	..	..	..	..	..	75-79
80-84	603-4,691-6		..	..	..	50-7	569-4,676-1		..	76-0	714-5		..	..	88-0	177-4,186-7		..	..	..	..	..	..	..	..	..	..	..	..	80-84
85-89	162-5,173-6		..	..	..	77-2	150-7,169-7		..	87-7	169-2,179-3		..	..	91-1	137-9,176-5		..	..	..	..	..	..	..	..	..	..	..	..	85-89
90-94	15-0,20-2		3-8	..	1-8	12-7,19-8		..	..	4-2	9-1,13-3		..	..	2-2	15-3,20-6		..	..	..	..	..	..	..	..	..	..	..	..	90-94
95-	..	..	1-0	6-2	..	..	..	..	..	1-1	6-3		..	..	7-3	..		..	..	..	..	..	..	..	..	..	..	..	95-	
All Ages	..	..	219-1	219-1	288-2	..	..	..	..	187-3	187-3	..	..	263-6	263-6	..	..	..	..	..	166-3	166-3	..	..	236-6	236-6	..	..	All Ages	

INSTITUTE OF ACTUARIES' AND FACULTY OF ACTUARIES' JOINT MORTALITY INVESTIGATION

BRITISH OFFICES EXPERIENCE (MALE PARTICIPATING ASSURANCES: 1893)
COMPARED WITH THAT OF H^M AND $H^{M(5)}$

SPECIMENS OF
ANNUAL PREMIUMS, AND OF RESERVES FOR EACH 100 ASSURED

$$\text{Where } 100_n V_x = 100 \left(1 - \frac{1 + a_{x+n}}{1 + a_x} \right)$$

Interest : 3 per-cent

x	n	$100P_x$				$100{}_nV_x$						n	x
		OLD EXPERIENCE		NEW EXPERIENCE		OLD EXPERIENCE			NEW EXPERIENCE				
		H^M	$H^M(5)$	O^M	$O^M(5)$	H^M	$H^M(5)$	H^M and $H^M(5)$	O^M	$O^M(5)$	O^M and $O^M(5)$		
$x + n = 55$													
0	35	1'427	1'582	1'306	1'410	43'18	41'70	43'71	44'15	42'92	44'30	35	20
5	30	1'625	1'745	1'524	1'603	40'59	39'58	41'14	41'26	40'38	41'42	30	25
10	25	1'880	1'959	1'790	1'846	37'25	36'81	37'84	37'74	37'16	37'91	25	30
15	20	2'192	2'268	2'116	2'156	33'15	32'80	33'78	33'42	33'07	33'60	20	35
20	15	2'589	2'657	2'524	2'555	27'96	27'75	28'64	28'03	27'81	28'22	15	40
25	10	3'114	3'185	3'046	3'072	21'09	20'91	21'83	21'11	20'98	21'32	10	45
30	5	3'801	3'879	3'730	3'753	12'10	11'91	12'92	12'66	11'98	12'29	5	50
$x + n = 60$													
0	40	1'427	1'582	1'306	1'410	51'24	49'91	51'63	51'98	50'87	52'06	40	20
5	35	1'625	1'745	1'524	1'603	49'02	48'09	49'43	49'49	48'68	49'58	35	25
10	30	1'880	1'959	1'790	1'846	46'16	45'71	46'59	46'47	45'92	46'56	30	30
15	25	2'192	2'268	2'116	2'156	42'64	42'26	43'10	42'75	42'40	42'85	25	35
20	20	2'589	2'657	2'524	2'555	38'18	37'93	38'68	38'11	37'87	38'22	20	40
25	15	3'114	3'185	3'046	3'072	32'29	32'04	32'83	32'17	31'99	32'28	15	45
30	10	3'801	3'879	3'730	3'753	24'57	24'31	25'18	24'38	24'25	24'51	10	50
35	5	4'725	4'797	4'641	4'661	14'19	14'08	14'88	14'01	13'94	14'16	5	55
$x + n = 65$													
0	45	1'427	1'582	1'306	1'410	59'13	57'96	59'41	59'71	58'75	59'75	45	20
5	40	1'625	1'745	1'524	1'603	57'27	56'44	57'56	57'62	56'91	57'66	40	25
10	35	1'880	1'959	1'790	1'846	54'87	54'44	55'18	55'08	54'59	55'13	35	30
15	30	2'192	2'268	2'116	2'156	51'92	51'54	52'25	51'97	51'63	52'01	30	35
20	25	2'589	2'657	2'524	2'555	48'19	47'91	48'54	48'08	47'83	48'13	25	40
25	20	3'114	3'185	3'046	3'072	43'24	42'97	43'63	43'09	42'89	43'14	20	45
30	15	3'801	3'879	3'730	3'753	36'78	36'48	37'21	36'56	36'40	36'61	15	50
35	10	4'725	4'797	4'641	4'661	28'07	27'89	28'57	27'86	27'74	27'98	10	55
40	5	5'987	6'069	5'872	5'887	16'18	16'08	16'76	16'10	16'03	16'18	5	60

The following gentlemen, nominated by the Council, were balloted for and elected as officers for the ensuing year:

President.

CHARLES DANIEL HIGHAM.

Vice-Presidents.

FRANK BERTRAND WYATT.
JAMES CHISHOLM.

ARTHUR FRANCIS BURRIDGE.
GEORGE FRANCIS HARDY.

Council.

HENRY WALSINGHAM ANDRAS.
*ARTHUR DIGBY BESANT, B.A.
*THOMAS G. C. BROWNE.
DAVID ALEXANDER BUMSTED.
ARTHUR FRANCIS BURRIDGE.
JAMES CHATHAM.
JAMES CHISHOLM.
FRANCIS ERNEST COLENZO, M.A.
HENRY COCKBURN.
ERNEST COLQUHOUN.
STANLEY DAY.
JOSEPH ERNEST FAULKS, B.A.
GEORGE FRANCIS HARDY.
AUGUSTUS HENDRIKS.
CHARLES DANIEL HIGHAM.

LOUIS FREDERICK HOVIL.
*WILLIAM HUGHES.
GEORGE KING.
GEORGE MACRITCHIE LOW.
GEORGE JAMES LIDSTONE.
HENRY WILLIAM MANLY.
*GEOFFREY MARKS.
HARRY ETHELSTAN NIGHTINGALE.
FREDERICK SCHOOLING.
*JOHN BELL TENNANT.
GEORGE TODD, M.A.
*SAMUEL GEORGE WARNER.
ERNEST WOODS.
FRANK BERTRAND WYATT.
THOMAS EMLEY YOUNG, B.A.

* Not Members of the last Council.

Treasurer.

HENRY COCKBURN.

Honorary Secretaries.

ERNEST WOODS.

| FREDERICK SCHOOLING.

On the motion of Mr. SEARLE, seconded by Mr. B. Woods, Messrs. Alexander Mackay (of the Law Union and Crown), H. E. Wilson (Northern Assurance Company), and A. M. Leveaux (Registry of Friendly Societies) were elected as auditors for the ensuing year.

Mr. LEVEAUX briefly responded, expressing the honour he felt by his election, and assuring the members that it would be his ambition to perform the work to the utmost of his ability.

Mr. T. G. C. BROWNE, in proposing a vote of thanks to the President, Vice-Presidents, Council, Officers, and Examiners, for the valuable services they had rendered during the past year, considered the report showed that the business of the Institute had been conducted with its usual efficiency and with more than its usual activity. The papers which had been read at the meetings, beginning most auspiciously with a Presidential Address that was distinguished both by its matter and by the excellent literary style it exhibited, showed a deep interest in those subjects which always commended

themselves to the attention of the profession. During the past year the Institute had had a little more than usual to do in its dealings with the outside world. In the first place, there was the International Actuarial Congress at Paris, when the Institute was adequately represented by its President and a number of Members of Council. Then there was the correspondence which took place with Somerset House in connection with the valuation of reversions. All actuaries, he thought, at times had suffered more or less from some little friction over the valuation of reversions, and he thought the understanding arrived at would be received with great satisfaction by the profession. It should be always borne in mind that in making valuations for probate purposes actuaries were not called upon to give their own personal views, or the views of their own particular office, as to what was a proper and advantageous price, but were asked to quote a fair value according to the market. It might sometimes be felt that in doing so a value was being quoted that was rather high, but if the market was prepared to pay that price, that was the price that ought to be quoted. The action of the Council in connection with the Patriotic Fund must be gratifying to the members. Rightly or wrongly there had been a feeling abroad that the administration of that fund had not been carried out in a way to benefit the great number of those for whom it was intended, and if by the action of the Institute the fund could be re-established in the confidence of the public, a very good work would be done. He considered that the Mortality Investigation would prove a landmark for a whole generation of actuaries and give them a new starting point. With regard to the Examiners, the office of Examiner was no sinecure. The labour had been continually increasing, and would probably tend to further increase. He had long thought—and he threw out the suggestion as a perfectly responsible individual—that the Institute was rich enough to give the Examiners some monetary recognition, whether the Examiners were Members of Council or not. He did not for a moment think that any fee the Institute could pay would really reward them substantially for their work, but they were entitled to some monetary recognition. Almost all great examining bodies deriving a considerable income from examination fees paid their Examiners, and he did not see why the Institute should not do so. He made the suggestion with a perfectly clear conscience, because he was getting too rusty ever to act as an Examiner again.

MR. A. H. BAILEY said that, as the oldest member of the Institute present, he had much pleasure in seconding the resolution. He had no intention of discussing matters, but would content himself with one remark. He had filled a good many offices. He came up for the first examination, which was held in the year 1850, along with six other men, including Mr. Porter, whose death was mentioned in the report, and the thing that struck him most particularly was that though only seven went up for the first examination, 179 went up fifty years afterwards. What the number was to be in the future was a very serious matter for consideration.

The resolution was carried with acclamation.

The PRESIDENT, in returning thanks for the re-election of the new Council and Officers, and for a vote of thanks to the old, wished that the Institute still included all who had been of them a year ago. They had had

their losses, and they were detailed in the report. Some names he had called attention to on previous occasions, but three more he would mention that day. Mr. Stephenson, the accomplished gentleman whose interests were not limited to the earning of his livelihood, and who at a ripe old age had left a name in science, and a memory of pleasant companionship to all who knew him as he was. Then Mr. Simon, amiable, capable, single-hearted in service and devoted in friendship, who had never made an enemy and never said a harsh word, and now he had gone from them and those he loved so well before he had seen fifty years of that life of theirs. And, lastly, M. Adan, President of the Association des Actuaires Belges, and a Corresponding Member of the Institute, who occupied a leading position among the actuaries of a sister kingdom and among those Continental brethren with whom it was a pleasure to think they were becoming more and more closely connected. And there were the others who had done their work and borne their part, and whom they did not forget as they entered into their labours. He heartily thanked those present, one and all, for their kindly words. They needed no stimulus, for their work was a pleasure, but had it been otherwise it could not have been more gracefully tendered than it had been that day.

Mr. HUGHES moved a vote of thanks to the Auditors, and in doing so mentioned that the large amount of work those gentlemen had performed had been performed with the greatest efficiency and care. It was with great regret the members learned that Mr. Dell was retiring, not because his term of office had expired, but because he was suffering from illness.

Mr. GORDON DOUGLAS, in seconding the motion, stated that in Scotland an endeavour was always made to do something towards paying the Examiners. It did not amount to very much, but it was something for the trouble which the Examiners took.

The resolution was carried unanimously.

Mr. L. K. PAGDEN, on behalf of the Auditors, briefly responded, pointing out that the work, although a duty, was a very pleasant one, and lightened by the great assistance received from the staff and the Secretary, who showed the Auditors every courtesy and attention.

At the conclusion of the Annual Meeting an Ordinary General Meeting was held for the purpose of electing certain foreign members, and the result of the ballot was the election of the following gentlemen as Corresponding Members:—MM. Serge De Savitch, Member of the Assurance Committee of the Ministry of the Interior, St. Petersburg; Corneille Louis Landré, Actuary of the *Algemeene Maatschappij van Levensverzekering en Lijfrente*, Amsterdam; Hermann Laurent, Dr.Sc., Vice-President and Membre agrégé de l'Institut des Actuaires Français, Paris; Anders Lindstedt, Dr.Phil., Government Superintendent of Assurance Offices, Stockholm; José Maluquer y Salvador, Insurance Counsellor (Actuary) at the Home Office, Madrid; Karl Samwer, Dr.Jur., Manager of the Gotha Life Assurance Company, Gotha; Thorvald Nicolai Thiele, Dr.Phil., Mathematical Director of the Hafnia Life Assurance Company, Copenhagen; and Guido Toja, Actuary of La Fondiaria Life Assurance Company, Florence.

Mr. Wm. Robertson Gaff, C.A., F.F.A., was elected an Associate.

COLONIAL EXAMINATIONS.

Examinations were held on 19, 20, 22, and 23 April, at Sydney, Melbourne, Adelaide, Wellington, Montreal, Toronto, and Ottawa, with the following results :

PART I.

Thirty-one Candidates sent in their names, of whom twenty-six presented themselves, and twenty passed as follows :

Class I :

FitzGerald, C. R. (Ottawa).	Grant, M. D. (Ottawa).
Gaines, J. M. (Montreal).	Tarr, S. R. (Toronto).
Traversi, A. T. (Wellington).	

Class II :

Blehl, E. M. (Toronto).	Ferguson, C. C. (Toronto).
Chubb, W. (Montreal).	Fisher, J. W. (Toronto).
Coventry, C. H. (Adelaide).	Nugent, J. (Montreal).
Dawson, M. M. (Montreal).	Taylor, L. W. (Toronto).

Class III :

Franklin, H. D. (Melbourne).	Hamilton, G. P. (Toronto).
Glassford, D. M. (Sydney).	Harpell, J. J. (Ottawa).
Hall, A. F. (Toronto).	Howell, A. R. (Montreal).
Latham, B. (Melbourne).	

PART II.

Twenty-five Candidates sent in their names, of whom twelve presented themselves, and four passed as follows :

Class III :

Mackenzie, M. A. (Toronto).

Class III :

Benjamin, S. O. (Melbourne).	FitzGerald, W. G. (Ottawa).
Papps, P. C. H. (Toronto).	

PART III (SECTION A).

Six Candidates sent in their names, two of whom presented themselves, and one passed as follows :

Class III :

McDougald, A. (Ottawa).

PART III (SECTION B).

Three Candidates sent in their names, all of whom presented themselves, and passed, namely :

Class III :

*Little, J. F. (Sydney).	Norris, C. A. (Melbourne).
*Thodey, R. (Sydney).	

Those marked * have now completed the Examination for the class of Fellow.

Additions to the Library.

The following works have been added to the Library since the publication of the *Journal* for October 1900:

	<i>By whom presented (when not purchased).</i>
Actuarial Society of America. Transactions of the	<i>The Society.</i>
Actuarial Society of Edinburgh. Transactions of the	<i>The Society.</i>
American Statistical Association. Quarterly publication of the	<i>The Association.</i>
Australian Mutual Provident Society. Fifty-second Annual Report, 1901.	<i>The Society.</i>
Austria. Bericht der Arbeiter-Unfall-Versicherungs-Anstalt für das Königreich Böhmen in Prag. 1899.	<i>Anonymous.</i>
Die privaten Versicherungsunternehmungen in den im Reichsrathe vertretenen Königreichen und Ländern im Jahre 1898.	} <i>The Government of Austria.</i>
Die Theorie des Policen-Rückkaufes in der Lebens- versicherung. By J. Altenburger.	
Mittheilungen des Verbandes der österr. und ungar. Versicherungs-Techniker.	<i>The Author.</i>
	<i>Anonymous.</i>
Awadzu (K). Collection of Essays on Insurance.	<i>The Author.</i>
Balfour (A. J.), M.P. British Industries and International Bimetallism. Speech by, and other Addresses.	<i>Purchased.</i>
Bastable (C. F.), M.A., LL.D. Public Finance. 2nd edition, 1895.	<i>Purchased.</i>
Belgium. Bulletin de l'Association des Actnaires Belges.	<i>L'Association.</i>
Bulletin de la Prévoyance.	} <i>Le Comité de Redaction.</i>
Compte Rendu des Opérations et de la situation de la Caisse Générale d'Épargne et de Retraite, 1899, 1900.	
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JOURNAL

OF THE

INSTITUTE OF ACTUARIES.

The Case for Census Reform. By G. H. RYAN, General Manager and Actuary of the British Empire Mutual Life Assurance Company, and Fellow of the Institute of Actuaries.

[Read before the Institute, 25 November 1901.]

ON the invitation of the President, I have undertaken, not without reluctance, to open the present Session with some observations upon the varied and interesting questions arising out of our Census system. The reluctance is to be explained as being due not to the disinclination to accept any task that may be thought to be of service to our Institute, but to the feeling that I have perhaps too readily consented to fill the part in the proceedings of the Session which has on some previous occasions been upheld by the President himself in a second inaugural address. The great interest excited by our President's address twelve months ago will cause legitimate regret that he should have ceded the place of honour and responsibility to a humbler member of the craft, thus adopting a course which, though also sanctioned by custom, leaves our anticipations unsatisfied. My fellow-members will be prompt to realise that this circumstance increases the anxieties with which I enter upon the subject of this evening's discussion, and will grant me that indulgence always extended to those who find themselves in a position to which they are unaccustomed.

We may approach the Census question by many lines of communication : one, the recognized thoroughfare of the statesman ; another, of the historian ; a third, of the physician ; a fourth, of the statistician ; a fifth, of the actuary ; and so on. But within a certain radius from the centre, the various interests reach common ground and commingle. This is the region of "demography", which is well defined by Mons. E. Levasseur as "the science of population, which defines its condition, studies its movements (principally in connection with birth, marriage, death, and migration), and embraces a knowledge of the laws which regulate it. It is the science of human life in the "social state." Thus understood, demography is the exclusive possession of no sectional interest, but belongs to and attracts the attention of all bodies of social and scientific students. It might be thought that our discussion of the subject should take account largely, if not entirely, of its actuarial aspects ; but I shall ask you to follow me in a somewhat broader treatment of the subject, and to consider to-night the important question of "Census Reform."

The literature of Census questions is fragmentary and scattered. In Great Britain, no work with which I am acquainted covers the same extent of ground as Mons. Levasseur's *La Population Française*, or Dr. Bertillon's *Cours élémentaire de Statistique*, though there is abundant room for such treatises in our country. Instead of such works of reference, we have to rest satisfied with the somewhat meagre reports of the Registrar-General, official publications (chief among them in interest being the Report of the Census Committee 1890, more fully referred to later on), and many highly interesting papers read before the Royal Statistical Society and our own Institute. But the gratitude of hundreds of students would be won by any writer who would collate information from the above and other available sources, such as the publications of the American Economic Association, and the official and statistical Bureaux of the American and Continental States. A comprehensive description and discussion of Census problems in their national and international bearings would form a valuable contribution to contemporary knowledge.

Hitherto for the sake of brevity I have used the vague term "Census question", but the ground covered by this abbreviation is of great extent, and it is no easy matter to make a judicious selection of materials so as to bring forward the chief points of

general interest without carrying these observations to an undue length. As most of the salient features and shortcomings in our system are brought out in the suggestions for its reform which have been made from time to time, we can scarcely do better than adopt as headings for discussion those sub-divisions of the subject under which the Census Committee, appointed by the Government in 1890, under the chairmanship of Mr. Leonard Courtney, conducted its inquiry. These are* :—

1. The periods and time at which the Census should be taken.
2. The nature of the organization required for its supervision and control.
3. The staff and accommodation needed for the central offices.
4. The appointment and payment of persons employed locally.
5. The information to be obtained.
6. The tabulation and publication of the results.
7. The nature of the legislation required.

As will be seen, the information and opinions contained in this essay are drawn from many sources besides the Report and Minutes of Evidence of the Census Committee. But this is not the first time that I have found official evidence of this kind of invaluable assistance in getting at the heart of a subject. The testimony given is the solemnly affirmed and deliberate belief of witnesses selected as a rule for their knowledge of the questions under consideration; and making due allowance for the enthusiast of extreme views and the official to whom views are obnoxious, there remains a solid body of facts and well-balanced opinion that makes these documents a most instructive source of reference. Every student of Census questions should master the Parliamentary Paper containing the Report of the Census Committee and the Minutes of Evidence.

1. THE PERIODS AND TIME AT WHICH THE CENSUS SHOULD BE TAKEN.

Much information of great interest concerning the numbering of the people in other parts of the world will be found in the works already quoted (Levasseur, p. 293-4; Bertillon, p. 144

* *Report of Census Committee*, 1890, p. vi.

et seq.), and as regards the Censuses of the United Kingdom and the Colonies and Dependencies, in the instructive papers of Mr. A. F. Burrige (*Journal of the Institute of Actuaries*, xxiii, 309; xxv, 83), and Mr. R. H. Hooker (*Journal of the Royal Statistical Society*, vol. lvii, part ii); while the Hon. Robert P. Porter, the Government Superintendent of the eleventh Census, taken in 1890, supplies abundant details of the utmost value in respect of the Census of the United States (*Journal of the Royal Statistical Society*, vol. lvii, part iv). For present purposes it will be sufficient to set out the intervals between the Censuses of the various countries according to their most recent practice, without going into matters of history.

We find, then, that the following summary gives us the bare facts under this head.

1. Great Britain has conducted its Census once every 10 years since 1801
Ireland " " 10 " 1811
2. Among the Colonies and Dependencies:

Victoria	has conducted its Census once every	10 years since	1861
New South Wales	" " "	10 "	1861
South Australia	" " "	10 "	1861
West Australia	" " "	10 "	1861
(but the Act of the Legislature sanctions the 5-year period)			
Queensland	has conducted its Census once every	5 years since	1875
Tasmania	" " "	10 "	1861
New Zealand	" " "	5 "	1881
Cape Colony	" " "	10 "	1891
Canada	" " "	10 "	1871
India	" " "	10 "	1871
3. Among Continental Nations:

France	has conducted its Census once every	5 years since	1821
Germany	" " "	5 "	1866
Sweden	" " "	5 " from 1775-1860	
"	" " "	10 years since	1860
Norway	" " "	10 "	...
Italy	" " "	10 "	1861
Austria	" " "	10 "	1880
Belgium	" " "	10 "	1846
Holland	" " "	} Census year varied	
Switzerland	" " "		
Greece	" " "		
Russia	" " "		
(First complete Census taken in 1897)			
Denmark	has conducted its Census once every	10 years since	...
Spain	" " "	10 "	1900
Portugal	(Irregular periods)		
4. United States has conducted its Census once every 10 years since 1790

The Administrative County of London (under the Equalization of Rates Act, 1894) makes an intermediate enumeration, thus adopting the principle and practice of quinquennial Censuses. But ages are not returned under these inquiries owing to a decision of the Local Government Board as to the proper construction of the Act.

The above analysis shows a marked preference for the ten-year interval according to present practice. The number of its adherents has been increased since the International Congress of Statistics, held in St. Petersburg in 1872, through several States having resolved to act upon the recommendation of the Congress that the enumeration of the population should take place not less frequently than once in ten years. But, even as a matter of precedent, the adoption of the quinquennial period by important countries like France, Germany and Sweden, by New Zealand and Queensland among our own Colonies, and lastly, by the Administrative County of London in our midst, must not be overlooked. Moreover, this is not a question that can be decided by a mere counting of numbers on the one side and the other. The trend of thought and opinion is at least of equal importance, and must be taken into equal consideration.

For a full century the United Kingdom has worked under a decennial Census; but for nearly half of that period an agitation for reducing the period from ten to five years has been more or less vigorously carried on. The Statistical Society has made repeated representations to the Government with this end in view; our own Institute has recently petitioned the authorities in the same sense (*see J.I.A.*, xxxv, 361); and, stronger than both, the Census Committee of 1890 made a similar recommendation. We shall do well, therefore, to consider the arguments in favour of quinquennial Censuses, the objections thereto, and the reasons why the change, so persistently advocated, has been resisted.

Well-informed opinion agrees upon the fact that one of the greatest advantages of a Census to the community lies in the teachings of vital statistics. Combined with the records of the Registrar-General's office, the population returns give us important information regarding the death-rate of the people as a whole, at the various periods of life, in numerous districts and subdivisions of the country, and (less faithfully, it is to be feared) in the several occupations recognized in the official classification. But the figures of the Registrar-General are collected continuously and published annually, while the population totals are made up but once in ten years. To obtain trustworthy death-rates, the recorded deaths (forming the numerator of the fraction) and the population among which the deaths occur (forming the denominator) must alike be accurate. The latter being only available as the result of a Census, recourse must be had for any

intervening years to an estimate based upon an assumed normal rate of increase in the population. If this estimate be confirmed by later experience, the conclusions derived from it are sound and correct, but should any abnormal movement occur in the population the estimate is upset, and all the conclusions, opinions and theories built upon it during the ten years are inaccurate and misleading. Now, for practical purposes, the population, taken as a whole, is not found to move very much from the hypothetical figures based upon the assumed constant rate of increase. For instance, taking England and Wales, the population on 5 April 1901, as estimated on the basis of the 1881-91 figures, was 32,383,619, while the actual population as enumerated was 32,526,075. The difference between the two totals is 142,456, or less than $\frac{1}{2}$ per-cent. This is as close an agreement as is necessary for practical purposes, especially when we bear in mind that conclusions based upon Census figures can only be accepted as of comparative value and not of absolute accuracy. But, from evidence given before the Census Committee of 1890, it is obvious that in the case of many cities, towns and districts, there were wide divergencies between the estimated and enumerated population.

“Salford proved to have a population of 16·4 per-cent, Oldham 18·4, and West Ham 25·6, above the Registrar-General’s estimate, and Dr. Ogle has since furnished us with a comparison of estimates and results (Appendix 1) for 5 counties, 20 great towns, 4 metropolitan sanitary areas, 17 other considerable urban districts, and 11 registration districts having small populations. Great discrepancies are shown in each of these classes. . . .” (*Report*, p. vi.)

Again, in the Preliminary Report of the Registrar-General on the Census of 1901 (dated 23 May 1901), a list is given of five towns where the enumerated population was considerably less than the estimated, and four towns where the reverse holds good; for example, Burnley with an estimated population on 5 April 1901 of 119,544 showed an enumerated population at that date of 97,044 only; and Liverpool with an estimate of 635,206 had an actual result of 684,947.

In all these cases the vital statistics, derived from the registration records and the estimated population for the intercensal period, were erroneous and misleading. Salford, for instance, may unnecessarily have deplored the existence of a high death-rate as a result of using too small a population over which to spread the registered deaths; and on the other hand

many towns may actually have been lulled into false security by the official figures. An interesting illustration of the errors in intercensal estimates of the population, and of the trouble arising from such errors, is afforded by the Borough of Eastbourne. In January 1901, Eastbourne invited applications from investors for a Corporation Stock, which, on the faith of the official figures showing the estimated population to be in excess of 50,000, was described as a trustee security (under the Trustee Act, 1893). The publication of later official estimates showed the number of the inhabitants to have been exaggerated, the true number being considerably less than 50,000. The Corporation was thus placed in a very awkward dilemma, and the capital subscribed had to be re-adjusted.* The moral and social effects of such errors may clearly be of far-reaching importance.

Whenever a population has full facility for movement from one district to another in response to the calls of industry and commerce, and avails itself freely of such facility, there must, as a matter of course, be frequent and considerable changes in the number and density of the inhabitants of different towns and districts. The steady migration of people from rural to urban communities—a feature not only of our own country but of France, the United States and probably other countries—is a case in point. All such circumstances tend to upset the estimated populations, and render the death-rates untrustworthy.

This is the main argument in favour of more frequent Censuses; but I shall venture to add another which I have not seen put forward. It is generally recognized that the ambition

* *Extract from letter to the author, under date the 19th October 1901, from the Town Clerk of Eastbourne:—"According to the Summary published by the Registrar-General of the estimated population of England and Wales, Eastbourne was shown, at the middle of 1899, to have a population of 51,227. This figure was, I understand, arrived at on the assumption that the population of Eastbourne increased in the same proportion as during the previous decade, and I am told it is the method which the Registrar-General has followed for the past 100 years in arriving at the estimated population of towns. When the prospectus of the Eastbourne Corporation Stock (Third Issue) was published in January 1901, the Registrar-General's summary of the estimated population at the middle of 1900 had not been published, but, following his method of calculation, the population at the beginning of 1901 would certainly have been more than 54,000, which we stated was the Registrar-General's estimate. When the summary was published, we found that he only estimated the population of Eastbourne at the middle of 1900 at 47,629. As a matter of fact, the Census, which was published still later, showed that the population in April 1901 was only 43,337. On making enquiries of the Registrar-General as to the reason why he should estimate the population at the middle of 1899 at 51,227, while at the middle of 1900 it should be put at 47,629, we were informed that he had corrected his estimate by allowing for the births and deaths and number of houses built, &c."*

of Census officials and statisticians is to make the returns more trustworthy than they are. Many leading authorities, such as Sir Robert Giffen and the late Dr. Ogle, have held that it is better to devote attention to rendering the facts obtained by a Census more accurate than to extend their scope; and with this all will agree. Now, in my humble opinion, there is no more potent influence in this direction to be found than frequent Censuses. The decennial enumeration is a strange thing in the eyes of the bulk of our population. The interval is too long for them to become familiar with it, to regard it as an ordinary, normal occurrence, to see that there is nothing to fear from it, or to learn to appreciate its utility and importance in the common good. Shorten the interval, and you do away with many of the obstacles to securing the support of the people and obtaining trustworthy returns. I believe this specially to be the case in regard to the particulars of age whose patent inaccuracy is the great blot upon the Census results. If people had to return their ages more frequently, there would be a strong tendency towards more faithful statements; they would become more accustomed to the inquiry, some of the glaring mis-statements would be avoided through a fear that the previous return might be remembered, and the "margin of error" would be reduced. If this reasoning be accepted, I cannot but think the argument for more frequent censuses is strongly reinforced. But even if it be otherwise, the plea, resting on the improvement and greater usefulness of our vital statistics, requires forcible countervailing objections to overbear it.

To the adoption of this much-desired change of system there are two great obstacles: official *inertia* and the objection of expense. Nothing is to be gained by discussing the former, but as regards the latter some points may be examined. The total cost of the Census of the United Kingdom in 1891 may be put at £185,000. At the worst, therefore, a further equal amount would need to be charged upon the revenues of a period of ten years. Let us say the increased annual cost of a quinquennial Census would be about £18,500, a sum that would make but little difference to the £100,000,000 or so which represents the normal national expenditure. But in two directions this cost could be materially reduced: first, by restricting the facts to be elicited at the intermediate Censuses to numbers, ages and sex, as recommended by Sir R. Giffen and supported by Sir R. E. (now Lord) Welby, and secondly, by re-arranging the enumerating districts and thus

simplifying the process of enumeration. In 1894 a deputation from the Royal Statistical Society waited upon the President of the Local Government Board, Mr. Shaw-Lefevre, himself a past President of the Society and a well-known advocate of Census reform. To the demand for a quinquennial Census and a permanent Census office urged upon him, Mr. Shaw-Lefevre replied as follows on June the 5th, 1894: "As an old President of the Royal Statistical Society, he felt very great sympathy with the object they had in view. If he could make out a sufficient ease for the Treasury, he would press it with all the means at his command. He had naturally consulted the Registrar-General, who had expressed the opinion that if there should be a quinquennial Census, it would be necessary to have a permanent staff, but that he had some doubts as to whether it would be necessary, if the decennial Census were to be maintained. The Registrar-General estimated the cost of the proposal at £1,500 per annum, and that it would not reduce the cost of taking the decennial Census. He did not know whether the Registrar-General had considered sufficiently that additional value might be obtained from the figures already at command. With regard to the quinquennial Census, he thought that the changes in the local authorities brought about by the Act of last year would render it extremely difficult to establish a Census in 1896. The Registrar-General had received notice of 380 changes in local authorities, many of which would not come into effect for some time to come. There would also afterwards be others, brought about by the Local Government Board, when the local authorities failed to make required changes. He did not consider the present a good opportunity to raise the question of a quinquennial Census in 1896; probably the matter would be considered for the next Census in 1901."*

Much has happened since 1894. The country's debt has been seriously increased, and the annual expenditure augmented by nearly 50 per-cent. The chance is, therefore, but a slender one that the additional burden of expense refused on financial grounds in 1894 will be accepted at the present time. But advocates for the greater efficiency and usefulness of our Census system should not recede from their position, but should continue to plead that this increase of expenditure will be a wise use of

* *J.R.S.S.*, vol. lvii, p. 382.

the nation's resources. Compared with other countries, Great Britain conducts its Censuses at a very meagre cost—the Russian Census of 1897, for example, cost £400,000, to say nothing of the last U.S. Census, on which was expended nearly £1,250,000—and it would be strange indeed if the people of this country whose minds have been encouraged to regard with equanimity a vast expenditure upon a system of national old-age pensions should evince any reluctance to bear a trifling additional expense for the more frequent enumeration of the population, which would certainly facilitate, even if it were not, as some hold, a necessary condition precedent of, any system of old-age pensions.

2. THE NATURE OF THE ORGANIZATION REQUIRED FOR THE SUPERVISION AND CONTROL OF THE CENSUS.
3. THE STAFF AND ACCOMMODATION NEEDED FOR THE CENTRAL OFFICES.
4. THE APPOINTMENT AND PAYMENT OF PERSONS EMPLOYED LOCALLY.

These points of reference, dealing with the internal machinery of the Census, may advantageously be considered together. In regard to organization, all the witnesses examined by the Committee concurred in attaching great weight to the necessity of a permanent Census Office. Under present arrangements, the organization is disbanded and dispersed as soon as the results of a Census are published; and it is not till some years later, on the eve of a new Census, that steps are taken to organize the work and gather together a staff. This is due to the peculiar nature of our legislation which does not recognize the Census as a permanent institution, but as a subject to be brought forward and discussed anew on the completion of each decade. The Constitution of the United States has the same antiquated and unpractical feature, strongly decried there as it is in our country. The weaknesses of the system are indeed manifest; for besides the loss of time in building up the organization afresh every ten years, and the waste of efficiency caused by disbanding the staff when fully trained to their duties and experienced in them, there is the loss of many intervening years during which useful and indeed urgently-needed work could be done. One of the most fruitful sources of trouble and expense is the confusion of enumerating

areas and districts. According to one authority,* there is "an extraordinary and increasing confusion of local divisions in the country, so that it is almost impossible to combine census information with other available statistics"; to another, "the changes in ecclesiastical and civil parishes, in towns and in urban sanitary districts, could be counted by thousands in the last ten years; and the population of each of these changed areas at the preceding Census should be ascertained" in order to make the vital statistics trustworthy and useful. In the opinion of a third, "the confusion as to areas was unfortunate and costly. A unit of tabulation should be fixed" He urges the Government "to round off the poor-law and registration districts so as to make them coincide with the municipal areas." A fourth statistician "wished the present conflicting and over-lapping areas could be simplified." In the same strain, the various witnesses called before the Census Committee spoke.

This obstacle to a speedy and efficient handling of the Census figures is a great defect in our system. The work of revising the local enumerating areas is highly important, but there is apparently no one to do it. The Parliamentary Committee were clearly impressed with the evidence on this head, and pointed out in their Report that the revision of the enumerators' districts could be taken in hand by the Census Office if the latter were placed on a permanent footing. This naturally led up to their recommendation that "a small census branch of the General Registry Office be established in England, if not also in Scotland and Ireland." It is disappointing that even this small change of practice should not have been adopted, though ten years have passed since the recommendation was made. But it is becoming increasingly necessary, and we must console ourselves with the thought that the heavy machine of State must eventually, however tardily, move in the desired direction.

The constitution of the Staff and nature of the accommodation provided for them may be briefly dismissed, not because of their want of importance but because the defects dwelt upon by the Committee are incidental to temporary employment and occasional work done at high pressure. The difficulty in suddenly securing

* *J.R.S.S.*, vol. lvii, p. 365.

a large body of suitable clerks, and the necessity of selecting them with the utmost care, are indeed obvious, especially as, in the words of the Census Report, "a very great deal of the work of these clerks cannot be checked." As before pointed out, the United States Census organization is likewise of a temporary character; but here the similarity stops. In the Act of March 1889, authorising the arrangements for the 11th Census (of 1890), permission was given to the Superintendent to appoint as many experts and specialists as were in his judgment required for the work. Mr. Porter, the official Superintendent, states, in a paper read before the Royal Statistical Society, that in this way the services of many leading authorities were secured. He gives a list of twelve names, which will be perused with astonishment at the eminence of these expert advisers and the variety of the interests they represented, and adds that "a score of other men" were also consulted. This, at any rate, is an indication of the earnest desire of the United States Legislature to have the work performed as well as circumstances and their unpliant Constitution permit. It evinces a sense of pride in having a thing thoroughly well done that is greatly to be admired. The same anxiety to secure the best available sources is seen in the selection of the Census officials in the United States:

"When a Committee of this Association (The American Economic Association) recently gathered a score of essays . . . their judgment coincided closely with that shown by the Census Office through its appointments. The person requested by our Committee a year ago to report upon the Census Statistics of Agriculture was invited by the Census Office some months later to become chief statistician in charge of that division. The person selected to write upon the Census Statistics of Manufactures was similarly honoured by the Census Office and in some degree as a result of the statistical ability shown in that essay. The other three appointments to similar rank were all persons requested by our Committee to prepare papers for the Association's monograph."—(W. F. Willcox. *Plans for the 12th Census in the United States*).)

In our country we pursue other lines which may or may not be equally well adapted to the peculiarities of our system. In evidence before the Committee of 1890, the leading officials of the Census Office explained that in the discrimination of doubtful boundaries and areas, time was frequently lost owing to the want of legal advice—"We have no lawyers in our Office, and were unable to get any official decision on the question." (Q. 233).

The list of "12 leading experts" and "a score of others" cannot be driven from one's memory when reading these words. It will, however, be remembered that what we should consider an excellent precedent was set by the employment of the services of our esteemed Vice-President, Mr. G. F. Hardy, in connection with the first general and simultaneous enumeration of the population of India in 1881, by which it may be said, without exaggeration, that not only was the particular investigation in hand largely benefited, but our knowledge of the scientific groundwork of the subject notably increased (see *J.I.A.*, xxv, 217).

Comparisons are not more favourable to us in the matter of accommodation. Prior to the U.S. Census of 1890, faulty accommodation and over-crowding existed, but a special building has since been erected, "extending over more than two acres at the north-west corner of the Capitol grounds in Washington." Here spacious offices have been prepared for 2,000 clerks and 50,000 enumerators. Our authorities do not require two acres, cut out of Hyde Park let us say, for the proper housing of the Census clerks; but we go sadly near to the other extreme. This is what Dr. Ogle tells the Census Committee (Q. 206). "The work was done in Craig's Court. . . . The buildings "caused an immense deal of difficulty and ill-health, and were "utterly unfit for the purpose." Again (Q. 282): "The offices "were very low, fearfully unventilated; they were fœtid by the "time the day was over, quite horrible to go into, and quite unfit "for any number of men to work in for a number of hours." On the strength of this evidence, the Committee reported that "an improvement in office accommodation was most desirable." Indeed, yes!

Dealing with the appointment and payment of the enumerators, the Committee pointed out that they are generally selected by the Registrars, and are as a body possessed of poor qualifications. Their remuneration is on a low scale, however—the average allowance comes out at about 5s. *per diem* for the week's work—and looking to this fact and the casual nature of the work, one could scarcely expect any other result. This is practically the conclusion at which the Committee arrived, as they have placed it on record that "they wish it were possible to secure a better set of men, but they see no radical remedy."

5. THE INFORMATION TO BE OBTAINED.

We now come to a question of the first magnitude in importance, about which a great deal has been written. What are the facts which a Census should seek to obtain? As usual, there are two distinct schools of thought, the one desiring the amplest information, such as the German and American Censuses collect; the other, with a studiously moderate list of requirements, comprising little more than the age, sex, position in the household, and occupation of the unit of population. The schedule in use in this country is in harmony with the latter view: it is probably the shortest of all, and has been but little extended on recent occasions. In 1891, particulars were asked as to "whether employer, employed, or neither", and as to the "number of rooms occupied if less than five." Otherwise the form has undergone no material change for many years. The general opinion is, that we may be satisfied with the limited amount of information now asked for until a permanent Census Office has been established and the principle of quinquennial enumerations adopted, when the field of enquiry may be gradually extended without much difficulty and with great advantage to the community. In Germany a separate industrial Census is conducted, of which Professor A. Marshall and other leading economists speak in high terms. But the immense profusion of questions asked in the American schedule represents the desire for information carried to the breaking-point.

By permission of the editor of the *Journal of the Royal Statistical Society*, I have appended a schedule setting out the facts asked for in the Censuses of the various portions of the British Empire, which appeared as an Appendix to Mr. Hooker's comprehensive paper on "Modes of Census Taking in the British Dominions", in June 1894. The table will, I am sure, be of great value to our members for purposes of reference, as it gives at a glance information that could otherwise be exhibited only in a confused and diffuse manner. We need not here go into the various suggestions that have been made for adding to the questions in the schedule. These are stated with all the weight of personal authority by their several advocates before the Census Committee. But the Census Executive wished for no enlargement of the inquiry, and consistently with the opinion I have already expressed, any

alterations in this direction should follow and not accompany the pressing reforms discussed in the last section.

While on the subject of the nature of the schedule, I may, however, shortly comment upon some of the statistics asked for in regard to the way in which they are collected and presented.

(a) *Sex*.—Little room for confusion would appear to exist in this heading. But the General Report of the Census of 1891 (vol. iv) points out a very curious error to have arisen, whereby perhaps as many as 10,000 persons were wrongly entered as females instead of males owing to “a personal tendency of the enumerators” to enter figures in the right rather than in the left of the two columns giving the ages by sex. As the Report points out “the transfer of 10,000 males to the female total may “be disregarded in a population of over 29,000,000”: but the incident is not assuring, and “personal tendencies” may be responsible for other errors which have not come to light. In spite of the labour involved, it is a question whether the schedules should not be independently read over with the enumerators’ abstracts before the latter are forwarded to the Central Office to be brought together in total. Actuaries, at any rate, know the danger of unchecked work in the masses of figures they have to deal with; and the casual discovery of this error, while reflecting credit on the official who detected it, casts a doubt upon the system under which it occurred. An interesting point as regards sex-distribution is the growing proportion of females to males in the population, owing chiefly to the continuous decline in the proportion of boys among the children born in this country, the increasing death-rate among males as compared with the female death-rate, and the greater loss by emigration among males. The proportions for the last five Censuses are :

In 1851	1,042	females to	1,000	males.
„ 1861	1,053	„	„	„
„ 1871	1,054	„	„	„
„ 1881	1,055	„	„	„
„ 1891	1,064	„	„	„

Strangely enough, the proportion in Russia, according to the Census of 1897, was 100 females to 100 males, though in St. Petersburg there were only 83 females to every 100 males. In France, the ratio of the sexes at the Census of 1896 was 102 females to 100 males.

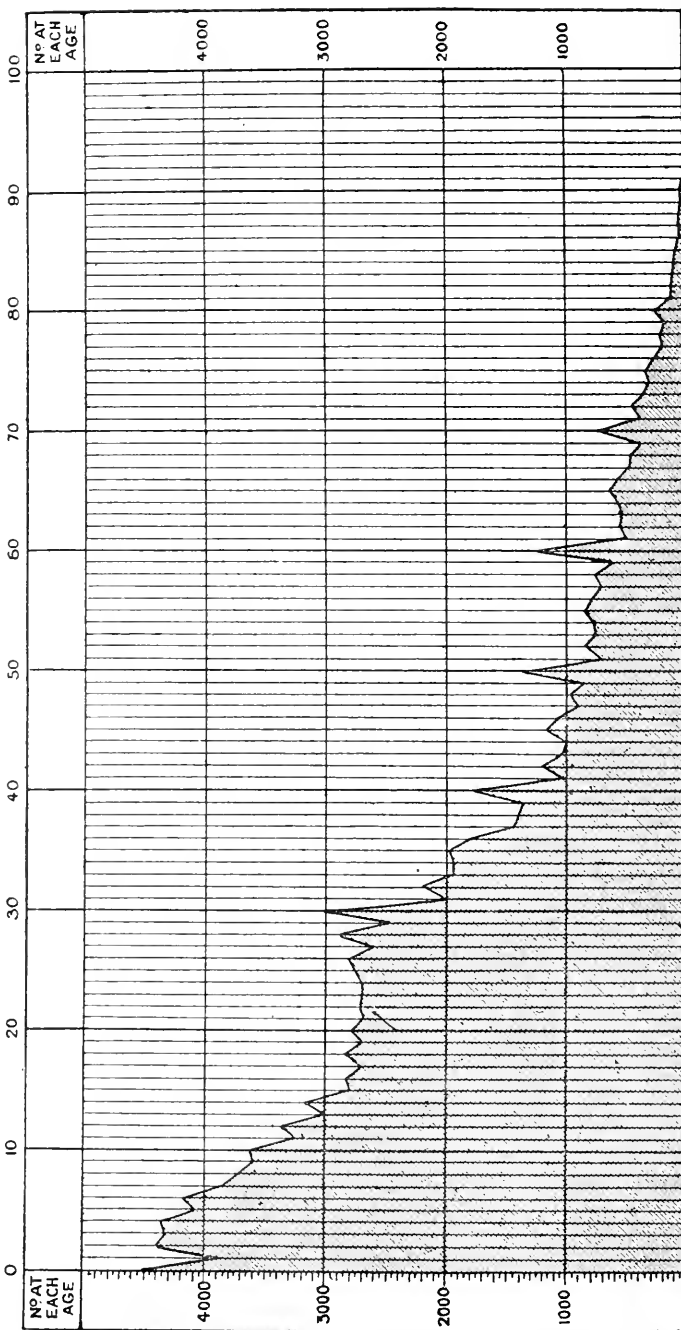
(b) *Ages*.—The patent defect in all vital statistics based upon population returns, whether of the Census Office as regards the living or of the Registrar-General as regards the dead, is the erroneous nature of the particulars of ages. Probably the records as to ages at death are open to less exception in this respect, as the element of self-interest has departed, and in the solemn surroundings of death the real facts of the case are more likely to be stated to the best of the declarant's belief. But, even here, genuine ignorance is an important factor, as well as a tendency to lean upon the remembered assertion of the deceased. Life Assurance Offices could compile a long list of faulty returns to the Registrar-General, in regard to which they hold trustworthy evidence of many years' date. But improvement in this matter can only come as the result of a better appreciation of the sovereign good of truth and accuracy; and if it come at all, will be of slow growth. Nevertheless, in the item of registration of death, our system loses nothing in comparison with that of other countries. It is surpassed in the extent of the information officially recorded by the system of New Zealand and some other colonies—for a notable example, in regard to the number of the children left by the deceased and their ages—but it is probably as accurate as that which is in force anywhere throughout the globe. For purposes of vital statistics, much remains to be done in more clearly describing the occupation of the deceased, such very difficult matters as double-occupations, and in the case of retired persons, no occupation, needing more satisfactory regulations.*

* See "Census Taking", by Dr. Dudfield, *J.I.A.*, xxxv, pp. 341 *et seq.*

But up to to-day, the United States, whose Census arrangements have been so favourably commented upon already, has no general system of registration of births, deaths and marriages, at all; indeed, according to several authorities, a change of constitution, naturally most difficult to effect, would be necessary to introduce this reform which is so ardently desired by American sociologists and statisticians.

In the matter of population ages, we are, however, probably no worse off than our neighbours. Looking at the official returns throughout the world, we can only conclude that there is an ineradicable tendency to mis-state ages at a Census. The oft-quoted practice of returning the age as some multiple of ten, though in reality the real age may be some years below or above the precise number, is as well marked abroad as in the United Kingdom. The diagram annexed gives a striking illustration of this tendency, drawn from the Census of Tasmania. In our own figures, we cannot prepare a corresponding diagram, owing to the absence from the official returns of the population at each year of age, as to which I shall have more to say later on; but the effect would admittedly be very similar.

DIAGRAM 1. NUMBER OF PERSONS IN TASMANIA LIVING AT EACH YEAR OF AGE ACCORDING TO CENSUS SCHEDULE; SHOWING THE TENDENCY TO CLUSTER AT ROUND DECENNIAL PERIODS



[This Diagram appears in Mr. Hooker's Paper, *J.R.S.S.*, vol. lvii, p. 347.]

There was reason to expect that the ages would be more correctly given in continental countries where the system obtains of requiring the "certificate of origin" or "acte de naissance" to be produced on most official occasions, and where in consequence there can be no ignorance of the true age of any individual. But the Census enumeration is not one of those occasions where these "papers" have to be produced; and as a matter of fact I believe that the usual motives of self-interest have the same play and produce the same results as elsewhere. For example, in France "all the later Censuses show a much greater number of females aged 20-25 than there are aged 15-20, and from the returns of 1886 it would appear that only about five-sixths of the number of females returned as between 20 and 25 years old are really of that age." (R. H. Hooker, *Journal of the Royal Statistical Society*, vol. lvii, p. 348.) The causes for all such mis-statements are of common notoriety. The greater demand for labour at particular ages, the reluctance of the young to pass a fresh decade, the desire of the old for that greater consideration and regard attaching to extreme old age, are all potential motives, and more could be easily named. Nothing can be done apparently to remedy this state of things, though, as I have already said, I believe more frequent Censuses would tend to greater accuracy in our own figures.

A final point as to ages is that the Census returns give the population not in years of age but in a rather haphazard arrangement. During the first five years of life, the figures are given separately for each year, from 5 to 25 in quinquennial groups, from 25 to 85 in ten-year groups, and from 85 onwards in a single total. A "graduated table of the estimated population" is however given at each year of age for males and females, but the process of graduation (or distribution) is not explained. Very strong remonstrances have been made against the omission from the returns of the actual figures in integral years of age. Thus Mr. C. S. Loch (*Journal of the Royal Statistical Society*, vol. lvii, p. 361) aptly says: "Neither in Census returns nor in the reports of the Registrar-General were the ages, as returned, set out year by year. As regards old-age pension schemes, much turned upon the number alive at a certain age—say 65—but the true number of those who were 65 was not known, and the number of those who said they were 65 was not published." On the same occasion, our esteemed past-President, Mr. Bailey, said "it was

“very desirable to ask for single years of age in the returns of population, because he believed actuaries might make better use of such a table than of one in which the ages were grouped quinquennially.” Professor Körösi, a statistician of European renown, also pleaded for the full returns, as tending to make the super-imposed mortality-tables much more valuable and authoritative. But the chief Census Official stated before the Census Committee (Q. 2,416) that “it would involve an enormous deal more printing.” A single page of the enumerated population side by side with the graduated population giving the full ages would, however, meet all that is required. And as this was one of the capital points put forward in the memorial addressed to the President of the Local Government Board by the Council of our Institute, we may yet hope for a reconsideration of the matter.

6. THE TABULATION AND PUBLICATION OF THE RESULTS.

The method adopted in our Census Office for dealing with the data obtained by the enumeration appears to be that the enumerator copies the householders’ schedules into a book, placing at the beginning an “abstract of the number of houses and persons, males and females, in his district, with due subdivision by parishes, sanitary districts, and so on. When the Registrar has received all the enumeration books of his sub-district, he makes a fresh summary from them for his whole sub-district. This he sends to the Census Office, and these summaries are there used for making the preliminary Census. The enumerator has cast the figures for his enumeration district; the Registrar has cast the figures of all his enumerators’ summaries to make totals for his entire sub-district; and in the Central Office these summaries are further cast to get district, county and other totals.” (Ogle, Q. 199.) The different facts contained in the enumeration books are afterwards transferred to tabulation sheets of different kinds—one for ages and civil condition, others for birthplaces, occupations, infirmities, &c. The sheets contain various compartments for the particulars as given in the final printed volumes. The work, it is stated, is constantly and carefully checked at every stage.

Thus the system in use in Great Britain is that by which the facts are re-arranged on written schedules. But there are two other plans adopted: the “card system” throughout Australasia

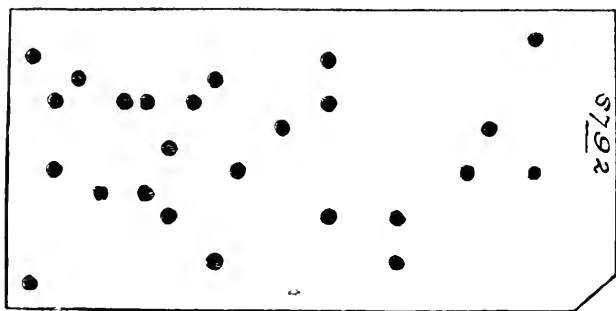
and in Cape Colony, and the Hollerith Electrical Tabulator in Canada, the United States and other foreign countries.

The Card System. In manipulating the materials used by Life Insurance Companies for the purpose of their actuarial valuations, the use of cards has long since supplanted the older system of classification on written schedules. In a variety of ways they are found handier. They render sub-division into the necessary groups and ages much simpler, and are undoubtedly a great saving of time and labour. Consequently actuaries will not be surprised to hear that their use for Census purposes in the several Australasian Colonies and Cape Colony has been attended with complete success. The forms of card are not uniform, owing to the difference in the extent of the information furnished by the population-schedules. For example, the New Zealand card contains a great number of particulars, and the Tasmanian relatively few. (Specimens of these cards will be found in Mr. R. H. Hooker's paper, *Journal of the Royal Statistical Society*, lvii, ii, p. 331-2). The New Zealand cards are so arranged that very few entries are required to be written in, and for these abbreviations were used as much as possible, the usual mode of record being by means of a bar drawn across the compartment corresponding to the particulars on each schedule. The Federation of the Australian Colonies, now happily achieved, will probably lead to uniformity in Census arrangements, and among minor things, in the form of card used throughout the continent. But it is of great interest to learn that the system works with ease, and gives satisfactory results; and any advantages it possesses would, it is reasonable to expect, be equally marked if it were applied in the classification of our own returns. The card system is employed in the valuation of Industrial Companies, and I have personally seen it in operation, in beautifully arranged method, in one of the largest Industrial Companies of America. It will be remembered that the Council of the Institute, in their Memorial to the President of the Local Government Board in July 1900, urged the adoption of this system in connection with our national statistics. We may fairly say, therefore, that the time has come when the mode of classifying and totalling our Census figures should be reconsidered, and the advantages of the card system thoroughly tested.

Hollerith Electrical Tabulating Machine. During the work of the tenth Census of the United States of America, the attention of Dr. Herman Hollerith was directed to the problem of providing

a mechanical device for facilitating the compilation of population and similar statistics. The result of his studies, after several years of experimental work, was embodied in the apparatus known as the Hollerith Electrical Tabulating Machine.

In the use of the machine, the statistical returns are first copied from the schedules in such a way that they may be "read" by the machine. The system adopted is that of punching holes in a card which has been divided into sections corresponding to the questions of the schedule. The relative positions of the holes on the card give the details of the answers of the individual represented by the card. The punched cards, having thus been prepared for each individual, can then be tabulated on the electrical machine. A fac-simile, slightly reduced in size, of the card for the head of a family in Chicago is here given; and, strange as it may seem, it is stated that so familiar do the clerks become with the position of the holes in the cards, that they can read them off at a glance.



COMPLETE CARD FOR ONE PERSON.

The inventor, in a paper read before the Royal Statistical Society (*Journal of the Royal Statistical Society*, lvii, ii), described the main features of the machine in the following words:—

The machine "consists primarily of a press or circuit-closing device, the upper or moveable portion of which is provided with projecting spring-actuated needles, or points, corresponding in number and relative position to the holes which may possibly be punched in the record card. The lower or fixed plate consists of a piece of hard rubber provided with a corresponding number of cups partially filled with mercury, which, through suitable wires, are connected with the binding posts of the switch-board. If a punched card is placed in this bed, and the

“handle depressed, wherever there is a hole in the card the needle will dip down into the mercury, while at all other points the needles will be pressed back.

“In connection with this so-called press, counters are used. A counter consists of an electro-magnet, so arranged that each time a circuit is closed through it the armature is actuated so as to register 1. These counters can readily be reset to zero, and will count to 9,999.”

If the machine is arranged so that a separate counter is connected with each mercury cup, the result of placing all the cards successively into the machine will be that the totals of all the items of the schedule represented by holes in the cards will be separately recorded on the dials, as, for example, the total number of males, females, &c.

The utility of the machine is not, however, restricted to the carrying out of a simple tallying operation of this nature. Its superiority over the old methods is shown by the fact that returns involving combinations of two or more replies can be made with scarcely any additional labour. For instance, if it is required to count age and sex in combination, the totals can be recorded by the machine by a simple use of the electrical relay. A detailed description of the adjustment of the wires necessary to enable the machine to record a combination such as “children of each age and sex, born of women of each age, legitimate or illegitimate”, is given by Dr. Jacques Bertillon, in his description of the machine (*Cours élémentaire de Statistique*, p. 74).

In connection with the machine is a sorting-box, the compartments of which correspond to the counters. Each time the dial of a counter registers, the lid of the corresponding compartment of the sorting-box is automatically opened by means of an electro-magnet, and the card can then be slipped into its proper compartment. By this means the operation of sorting can be conducted simultaneously with the counting, and the cards prepared for a further sub-division of the classification just completed.

I am afraid this technical description of the Hollerith machine will be rather tedious to follow, and moreover will fail to convey any very definite impression to the mind. But the signal achievement of classifying and totalling a variety of facts at a single operation will not fail to be appreciated. The Hollerith machine aims at doing more for general statistics than the

arithmometer does for the simpler forms of arithmetical calculation, and actuaries would readily testify to the immense aid of the latter machine in dealing with large masses of figures.*

The Hollerith machine was employed in the 11th Census of the United States (1891), and gave unqualified satisfaction. "For the first time it was possible", writes Mr. Porter, the Census Superintendent, "to aggregate from the schedules all the information desirable."† The manipulation of the 63 million schedules took only half as long on the machine as by the old method of re-scheduling on special forms, and the result was admitted to be quite as free from error. Dr. Bertillon says of it (*Cours élémentaire de Statistique*, p. 72), "The machine has the great advantage of giving to the statistician the most varied and complex results, almost without additional work. It is on that account that, having been adopted in America, it has been taken up by Canada and Austria.‡ It is actually on trial in Rome, and the Bureaux de la Statistique of Italy; in Berlin, in the Bureaux de la Statistique des Douanes, and in Paris."

Since these words were written, at least one other Continental nation has employed it, the Census results of Russia, in 1897, having been classified by the aid of 70 Hollerith machines.

After such tests as these, there is no longer any doubt as to the extreme value of the machine in statistical work. Its merits have long been known to our leading statisticians, and were freely urged upon the notice of the Census Committee in 1890. Members of that body were much impressed by the strong testimony in its favour, and recommended that the executive of the Census Office should carefully consider the advantage of employing it. One distinguished official of the Census Office (in 1894) "longed for another Census to try the Hollerith machine. "If in our next Census the machine should be tried, it would open out possibilities for an immense increase of valuable statistics without corresponding cost."§ Again, he expressed the opinion that "no doubt some electrical machinery would be

* *The applicability of the Hollerith machine to the classification of insurance statistics in connection with the investigation of mortality experience and actuarial valuations is a subject that demands special and separate consideration.*

† *J.R.S.S.*, lvii, 658.

‡ 12 Hollerith machines were used in the Austrian Census of 1890.

§ *J.R.S.S.*, lvii, 683.

“ so perfected during the current intercensal period as would
“ make it absolutely imperative for England to adopt it.”* But
this gentleman had never seen it in use, “ though Dr. Ogle had
inspected it in Vienna.” One would have thought the resources
of the country sufficient to justify the necessary expenditure for a
machine to be tested and investigated, as recommended by the
Census Committee; but that is apparently not our way of setting
about things. Mr. R. H. Hooker, in his paper already quoted,
says:—“ It is, I believe, recognized that the device would not
“ have so much value (as in the United States and Canada) in
“ the United Kingdom and other Colonies where the number of
“ details is not so great. Much time is occupied in punching
“ the cards.”† Mr. J. A. Baines (in a paper read before the
Royal Statistical Society in March 1900) writes:—“ As to the
“ Hollerith machine, two chances of error exist, (1) In feeding
“ the machine very quickly connection in the current may be
“ missed, (2) the whole operation depends upon accurate
“ punching.” He adds:—“ The machine would only be of use
“ in England in connection with occupations.”‡ On the other
hand, Mr. W. F. H. Wilcox, in a “ Note on American Census
Practice” (*J.R.S.S.*, vol. lxiv, iii), says:—“ Undeniably this
“ transcription introduces errors, and, as it is the first step in the
“ office work, the attendant errors may properly be called initial
“ office errors. But the vital question seems to be: how do the
“ errors under this form of transcription compare in number or
“ importance with those under the form of copying in long hand?
“ Copying may be done either in the central office by trained
“ clerks or in the field by enumerators. Evidence regarding the
“ comparative accuracy of copying and punching, when both are
“ done by trained clerks under strict superintendence, is found in
“ the experience of the New York Central Railroad. The freight
“ office of that road formerly copied its way bills in long hand,
“ but recently, and after experiments extending over several years,
“ it adopted the electrical system of tabulation. The auditor of
“ freight accounts stated to a commission of the United States
“ Census Office, that after the change the average amount of
“ work done by the copying clerks increased nearly one-half, but

* *J.R.S.S.*, lvii, 366.

† *J.R.S.S.*, lvii, 341.

‡ *J.R.S.S.*, lxiii, 50.

“ the average number of errors showed no increase, and therefore
“ the ratio of errors to work done declined. On this point I have
“ met with no other evidence. That cited warrants the belief
“ that, when other conditions are equal, transcription by the
“ punching machine is more accurate than transcription with a
“ pen. . . . However that may be, it seems clear that the
“ error in copying entries by punching holes in a card under the
“ American system is no greater than the error in other forms of
“ copying, and that this small error may be reduced cheaply and
“ easily almost to any desired degree by verification of cards
“ selected through the machines as inconsistent or unusual.”

Most people will not be discouraged by the chances of error in the use of so well-contrived a machine, remembering in connection with our system the comments of the Census Committee on the staff, “ a very great deal of whose work cannot be checked.” In any case, the whole statistical world would be deeply interested in knowing that a thorough test was being made of the capabilities of the machine and in learning the result of the experiment. It is to be hoped that our Census Office will before long make such an investigation and show themselves desirous of benefiting by the experience of others.

I have given perhaps a disproportionate space to describing the machine, which greatly interested me, and the possibilities of which seemed to me quite remarkable.

7. THE NATURE OF THE LEGISLATION REQUIRED.

Sufficient has been said to show that many of the defects in the working of our Census system have their origin in the necessity that exists for a separate Act of Parliament before any preparations can be made for the work. The chronic pressure of public business in the House of Commons invariably leads to a postponement of this unsensational, this rather humdrum question till the last moment, with the inevitable consequence that haste and inefficiency mark the arrangements from the very beginning. There is but one way of removing this recurring cause of trouble and discontent, namely, by an Act giving to our Census the status of a permanent institution. In the words of the Census Report this “ would be advantageous, “ alike as effecting an economy of the time of Parliament, and as

“enabling the departments concerned to make” timely arrangements. Amending legislation would be just as possible and practicable in this as in the other institutions of the country regulated by permanent as distinct from periodic laws. It is noteworthy that the Censuses of the United States depend upon statutes specially passed *ad hoc*, and there also this leads to a regrettable shortening of the time for making preparations for the work, and is condemned by statisticians and sociologists. It would be difficult to define how much of the improvement hoped for in our Census system is wrapped up in this urgent reform, which indeed involves no new principle or structure, but would merely embody those that exist in the standing laws of the land.

Having now pursued in detail the inquiries of the Census Committee, it may be well to place on record the text of the several recommendations of the Committee.

Summary of Committee's Recommendations.

- (a) that the number of the population and its distribution as regards age and sex, be ascertained midway between the decennial periods at which a full Census is taken;
- (b) that the areas for which the results of such an enumeration are tabulated be restricted to registration counties, districts and sub-districts, administrative countries and sanitary districts, urban and rural;
- (c) that if the enumeration be taken more frequently than hitherto a small permanent Census branch of the department of the Registrar-General be established in England, if not also in Scotland and Ireland;
- (d) that, except to the extent to which second division clerks may be employed under the conditions which have been proposed by the Registrar-General for England, the Census clerks selected for employment under that officer be chosen by open competition within suitable limits of age;
- (e) that the special attention of Superintendent-Registrars and Registrars be called to the importance of a very careful selection of enumerators;
- (f) that in addition to the information hitherto obtained, columns be added to the householders' schedule for enabling persons to be returned either as employers, employed, or neither employers nor employed, the propriety of publishing such returns to be a matter for subsequent determination;

- (g) that the term "rank" be omitted from the column hitherto provided for "rank, profession, or occupation;"
- (h) that persons following no occupation, but deriving an income from property and other sources of a permanent character, be so returned, and that they be separately tabulated in the published reports;
- (i) that provision be made at the foot of the householders' schedule for a statement as to whether the number of rooms occupied is less than five, the actual number in that case to be given, the publication of the results to be afterwards decided as under (f);
- (j) that provisions as to the taking of a periodical Census be embodied in a Bill of a permanent character.

In addition to these recommendations the following matters were presented for further consideration :

- (a) the re-arrangement of enumerators' districts and pay ;
- (b) the nature of the office accommodation provided ;
- (c) the payment of Superintendent-Registrars and Registrars ;
- (d) the further extension of the information obtained as to industrial status ;
- (e) the revision of the instructions printed at the back of the householders' schedule ;
- (f) the issue of special instructions as to classification of occupations in particular districts ;
- (g) the use of mechanical appliances in the work of tabulation ;
- (h) the inclusion in the published reports of any instructions to enumerators likely to throw light upon the statistics obtained.

Outside the comparatively unimportant suggestions made for extending the particulars in the schedule, the foregoing recommendations have been ignored, and our system stands as much as ever in need of material reform. The efforts of all those who are interested in seeing the objects and advantages of our Census efficiently secured must not, however, be relaxed. The tendency of other countries is more and more to recognize the necessity in the common good of improving their machinery. Almost alone among the greater nations of the civilized world, we seem to rest passive and indifferent, alike to remonstrance, to official recommendation, and to the pride of doing in the most creditable and praiseworthy manner the work that lies to our hand. But the

public interest requires that indifference should be met with active criticism and insistent appeal. Only by such means shall we apply the requisite stimulus, and secure those alterations in our existing system which well-informed men are practically unanimous in regarding as urgently needed.

APPENDIX.

It may be useful for a few moments to pass from the storm and stress of public controversy to some matters of more general importance in regard to our population. The growth of the population of England and Wales since the first Census was taken in 1801 is set out in the following table, along with the decennial rate of increase:—

ENGLAND AND WALES.

Date of Enumeration	Number of Inhabited Houses	POPULATION			Increase of Population since last Census	Decennial Rate of Increase per-cent †
		Persons	Males	Females		
1801—10 March	1,575,923	8,892,536	4,254,735	4,637,801	...	...
1811—27 May	1,797,504	10,164,256	4,873,605	5,290,651	1,271,720	14·00
1821—28 May	2,088,156	12,000,236	5,850,319	6,149,917	1,835,980	18·06
1831—29 May	2,481,544	13,896,797	6,771,196	7,125,601	1,896,561	15·80
1841— 7 June	2,943,945	15,914,148	7,777,586	8,136,562	2,017,351	14·48
1851—31 March	3,278,039	17,927,609	8,781,225	9,146,384	2,013,461	12·89
1861— 8 April	3,739,505	20,066,224	9,776,259	10,289,965	2,138,615	11·90
1871— 3 April	4,259,117	22,712,266	11,058,934	11,653,332	2,646,042	13·21
1881— 4 April	4,831,519	25,974,439	12,639,902	13,334,537	3,262,173	14·36
1891— 6 April	5,451,497	29,002,525	14,052,901	14,949,624	3,028,086	11·65
*1901—31 March	6,266,496	32,526,075	15,721,728	16,804,347	3,523,550	12·17

* Preliminary Report, 1901.

† These rates have been corrected for the varying lengths of the intercensal periods.

The rate of increase is here seen to vary from 18·06 to 11·65. Splitting the century into halves, the rate of increase was 15·05 from 1801 to 1851, and 12·66 from 1851 to 1901; or, taking the century as a whole, the rate of increase works out at 13·85. Now, various hypotheses may be made as to the rate at which the population will increase during the new century. On the basis of the last decennial rate of increase (12·17), the population

of England and Wales in 2001 would be about 102,000,000; on that of the whole 19th century (13·85), it would be about 119,000,000; on that of the first half of the last century, about 132,000,000; and on that of the last 50 years, about 107,000,000.

It may be pointed out that the actuarial formula for the period in which capital doubles itself at compound interest may be applied to the case of populations.

The formula (omitting the small constant correction) is

$$n = \frac{\cdot 693}{i},$$

where i is the annual rate of interest at which capital constantly accumulates, and n is the number of years in which the unit of capital is doubled.

If instead of i , the annual rate of interest, we substitute r , the decennial rate of increase, we have n (the number of decennial periods in which a population doubles itself if it is growing continuously at the decennial rate r per unit)

$$= \frac{\cdot 693}{r} \left\{ \begin{array}{l} \text{or as the rates of increase are} \\ \text{usually given for 100} \end{array} \right\} = \frac{69\cdot 3}{100r}.$$

For example, if the last decennial rate of increase remain constant (for 1891–1901, or 12·17 per-cent), the population, on 5 April 1901, would be doubled at the end of $\frac{69\cdot 3}{12\cdot 17}$ decennia, or 5·69 decennia, or 56·9 years. And obviously it would quadruple itself in twice this period, or 113·8 years. It is suggested that such an easy rule as this may sometimes be of use to statisticians when dealing with population and other figures.

Probably unless the conditions undergo any material change, the population of England and Wales will number 100,000,000 at the close of the 20th century. Needless to say, accidents or internal or international convulsions may entirely upset this forecast; but if it is reasonably probable, what a vast field of speculation is opened out by it. Great Britain would then be more densely populated than any area in the whole world now is, with enormous aggregations of persons in all centres, and, as a new necessity of national life, a populous rural community. The present relative density of the various peoples is as follows:—

Population of Europe.

COUNTRY.	Area in 1,000 Square Miles	Population in Thousands	No. of People to each Square Mile
Belgium.	11.4	6,195	543.4
Holland.	12.7	4,670	367.7
Great Britain.	121.6	38,780	318.9
Italy	110.6	30,536	276.0
Germany	210.4	49,428	234.9
France	207.1	38,343	185.1
Switzerland	16.0	2,953	184.6
Austro-Hungary and Bosnia-Herzegovina	261.3	43,212	165.4
Denmark	15.3	2,186	142.9
Portugal	35.4	4,576	129.3
Servia	18.6	2,227	119.7
Roumania	50.6	5,800	114.6
Spain	192.0	17,248	89.8
Bulgaria, Eastern Roumelia	37.3	3,310	88.7
Greece	25.1	2,217	88.3
Turkey	67.8	5,753	84.9
Russia	2,045.7	100,219	49.0
Norway and Sweden	299.6	6,796	22.7
Other European States	4.9	447	91.2
Total	3,743.4	364,896	97.5

(Compare Bertillon, p. 425.)

The statesman must step in where the statistician stops, and it will be his duty, not ours, to consider the problems of providing food-supplies for a population swollen to these great dimensions, and of dealing with the other questions vital to the nation's prosperity or even existence. But this brief excursion into the realms of the unknown may serve to show the tasks that await our future rulers.

If any known element were, however, to upset all such forecasts, it would probably be the very remarkable decline in the birth-rates of many countries. The United Kingdom, the United States and Germany, to name only three, as well as France where the feature has long been recognized and lamented, show declines in the birth-rate which are difficult to account for on any common ground. And yet the coincidence can hardly be accidental. In many such matters the horizon is constantly widening, and unlimited scope exists for the theories, speculations and investigations of a latter-day Malthus. As a further casual illustration of the importance

of population statistics, consider what lessons can be read into the figures given in the following table, which shows the natural increase (disregarding the influence of migration) of the various European States.

INTERNATIONAL VITAL STATISTICS.

Birth-rates and Death-rates in the United Kingdom and in other European States.

Country	1874			1899			Difference in Natural Increase 1899—1874
	Birth- rate per Thousand	Death- rate per Thousand	Natural Increase	Birth- rate per Thousand	Death- rate per Thousand	Natural Increase	
United Kingdom	34.4	21.5	12.9	28.7	18.3	10.4	— 2.5
Denmark . . .	30.9	20.0	10.9	30.1	17.5	12.6	1.7
Norway . . .	30.7	18.2	12.5	30.9	16.8	14.1	1.6
Sweden . . .	30.9	20.3	10.6	26.2	17.6	8.6	— 2.0
Austria . . .	39.7	31.7	8.0	37.1	25.4	11.7	3.7
Hungary . . .	42.7	42.6	.1	39.0	27.0	12.0	11.9
Switzerland . .	30.5	22.4	8.1	28.9	17.6	11.3	3.2
German Empire .	40.1	26.7	13.4	35.9	21.5	14.4	1.0
Prussia . . .	40.1	25.8	14.3	36.4	21.4	15.0	.7
The Netherlands	36.4	22.7	13.7	32.0	17.1	14.9	1.2
Belgium . . .	32.6	20.5	12.1	28.8	18.8	10.0	— 2.1
France . . .	26.1	21.4	4.7	21.9	21.1	.8	— 3.9
Italy . . .	34.9	30.3	4.6	34.2	22.1	12.1	7.5

[The above table is compiled from the figures given in the Sixty-second Annual Report of the Registrar-General for 1899, p. cxxvii.]

Countries showing an Increase in the Natural Growth of the Population, comparing the Returns for the Individual Years 1874 and 1899 :—

	Increase per 1,000.
Hungary	11.9
Italy	7.5
Austria	3.7
Switzerland	3.2
Denmark	1.7
Norway	1.6
Netherlands	1.2
German Empire	1.0
Prussia . . . . .	.7

Countries showing a Decrease in the Natural Growth :—

	Decrease per 1,000.
France	3.9
United Kingdom	2.5
Belgium	2.1
Sweden	2.0

One statement we may venture upon: namely, that the condition of all peoples, present and future, may be inferred more accurately from carefully collected and well prepared statistics, derived from Census and official statements, than from other sources at present available. Hence, it is desirable that fuller attention should be devoted to these questions by scientific bodies—may I say in particular by the Institute of Actuaries.

Reference has been made to the fact that we possess no standard text-book in our literature to be compared with the works of Levasseur and Bertillon in France. Sir W. Rawson Rawson, in his evidence before the Census Committee (Q. 881), referred to the difficulty of obtaining information of Censuses of the Empire. "It is very hard upon anybody who wishes to study questions dependent upon the population of the Empire. . . . Instead of finding in one volume the information relating to the population of the Empire, we have to get the volumes relating to England, Scotland and Ireland separately; then to go to the Blue Books, published only every three years by the Board of Trade, to get some information (not information tallying with the British Census, but such information as is given there briefly) as to the other parts of the Empire." I do not profess to have covered one tenth part of the ground in my reading for purposes of this paper; but the list of references consulted, given in a separate appendix, will show how far afield one has to go who wishes to acquaint himself with some of the phases of the subject. A permanent Census department might occupy the slack years between two enumerations by collating information, and by publishing Imperial and Foreign statistics of great value. Failing this, it is earnestly to be hoped that a sense of public spirit and the certainty of public appreciation will induce an experienced statistician to give his time and thought to the production of a volume in which will be investigated the life and movement of our people in all its physical and social phases. Let us consider what such a book could do. It could analyze the Census figures for every integral part of the Empire, compare the methods of deducing from the raw material the finished result, and in this way surely, if with no set purpose, prepare the way for uniformity. It could bring together the most important results given in the Registrar-General's annual reports, examine the system of classification of deceased persons according to occupation; investigate birth-rates, marriage-rates,

APPENDIX: TABLE A.—Scope

	1	2	3	4	5	6	7	8	10 11 12			
	Number and Sex	Houses	Crowding in Houses	Ages	Conjugal Condition	Divorced	Birth-place	Religion	OCCUPATIONS			
									Number in each Profession	Employers or Employed	Unemployed	Breadwinner or Dependents
and Wales	x	x	x	x	x	—	x	—	x	x	—	—
and	x	x	x	x	x	—	x	—	x	x	—	—
and	x	x	x	x	x	—	x	x	x	x	—	—
	x	x	—	x	x	—	x	x	x	—	—	—
	x	x	—	x	—	—	x	x	x	—	—	—
ria.	x	x	—	x	x	x	x	x	x	x	x	x
South Wales†	x	x	—	x	x	x	x	x	x	x	x	—
ustralia†.	x	x	—	x	x	—	x	x	x	x	x	—
ustralia.	x	x	—	x	x	x	x	x	x	x	x	x
island.	x	x	—	x	x	—	x	x	x	—	—	x
ania.	x	x	—	x	x	x	x	x	x	x	x	x
Zealand.	x	x	—	x	x	—	x	x	x	x	—	x
Colony.	x	x	—	x	x	x	x	x	x	—	—	x
	x	x	x	x	x	—	x	—	x	—	—	—
la†	x	x	—	x	x	—	x	x	x	x	x	—
oundland	x	x	x	x	x	—	x	x	x	—	—	—
ica	x	x	—	x	x	—	x	—	x	—	—	—
ard Islands	x	x	—	x	x	—	x	—	x	x	—	—
ados	x	x	x	x	x	—	x	x	x	—	—	—
dad	x	*	—	x	x	—	x	x	x	—	—	—
h Guiana	x	x	—	x	x	—	x	—	x	—	—	—
	x	x	x	x	x	—	x	x	x	*	—	—
us.	x	x	—	x	x	x	x	x	x	—	—	—
ts Settlements	x	x	—	x	x	—	x	—	x	—	—	—
g Kong.	x	x	*	*	—	—	x	—	x	—	—	—
Coast	x	x	—	*	—	—	—	x	x	—	—	—
itius	x	x	*	x	x	—	x	x	x	—	—	—

* See, in Part III of Mr. Hooker's Paper, the Colony referred to.

† Census returns not complete (1894).

‡ Hollerith electrical machine used.

of the different Censuses.

13 EDUCATION		15 16 17 18 SICKNESS AND INFIRMITY				19 20 SPECIAL INQUIRIES		21	22	23	24
Read and Write	Receiving Education	Blind, Deaf and Dumb, Mental	Sickness	Lepers	Epileptic and Paralytic	Race	Language	Schedule left at House	Card System used.	Agricultural Statistics Collected	Industrial Statistics Collected
—	—	×	—	—	—	—	W.	×	—	—	—
—	×	×	—	—	—	—	G.	×	—	—	—
×	×	×	×	—	—	—	I.	×	—	*	—
×	×	×	—	×	—	—	×	—	—	—	—
×	—	×	—	—	—	—	—	×	—	—	—
×	×	×	—	—	×	Ch. A.	—	×	×	×	—
×	×	×	×	×	×	Ch. A.	—	×	×	×	×
×	×	×	×	—	×	A.	—	×	×	×	—
×	×	×	×	—	×	Ch. A. H.	—	×	×	×	—
×	×	—	×	—	—	Ch. P.	—	×	×	—	—
×	×	×	×	—	×	Ch. H.	—	×	×	—	—
×	×	×	×	—	×	Ch. Mao.	—	×	×	×	×
×	×	×	×	—	×	×	—	×	×	×	—
—	—	—	—	—	—	In.	—	×	×	—	—
×	—	×	—	—	—	F.	—	—	+	×	×
×	×	×	—	—	—	—	—	—	—	×	×
×	—	×	—	—	—	E.I.	—	×	—	—	—
—	—	×	—	×	—	—	—	—	—	—	—
—	×	×	—	×	—	—	—	×	—	—	—
—	×	×	—	×	—	E.I.	—	×	—	—	—
×	—	*	—	*	—	E.I.	—	×	—	—	—
×	—	×	—	—	—	— {	Mal. {	×	—	×	—
—	—	×	—	×	—	— {	It. {	×	—	—	—
—	—	—	—	—	—	—	—	×	—	—	—
—	—	—	—	—	—	Ch.	—	×	—	—	—
—	—	—	—	—	—	*	—	—	—	—	—
—	×	×	—	—	—	E.I.	—	×	—	—	—

Col. 19.

A. = Aborigines.
 Ch. = Chinese.
 E.I. = East Indians.
 F. = French Canadians.
 H. = Half-Castes.
 In. = Indians under Indenture.
 Mao. = Maories.
 P. = Polynesians.

Col. 20.

G. = Gaelic.
 I. = Irish.
 It. = Italian.
 M. = Maltese.
 W. = Welsh.

and death-rates in the various sub-divisions of the people and of the country; and, in short, trace the national life in its multiform phases. Then it could embrace in a special section the results and methods of the population statistics of the chief Continental nations, investigating their growth or fluctuations, and thus bring home important lessons, not only to statisticians but also to those of our rulers who regard the problems of the future as well as those of the present. Finally, it could deal with the correct handling of statistics, their use and abuse, the well-founded deductions and the fallacious generalizations. Such a work would not be beyond the powers of one of our own members, who, by the aid of industry and the exercise of judgment, might bring credit alike upon our Institute and himself.

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- La Population Française.* By E. Levasseur. Paris, 1889

DISCUSSION.

The PRESIDENT said he was sure that the Members would be glad that the manifold occupations of the President had compelled him to follow the example of those of his predecessors who only gave one inaugural address. He was inclined to think that if those occupations continued to increase in the same ratio, his successors would not be able to find time for an address at all. In recollection of his previous labours, he would ask Mr. Burridge to open the discussion, and Mr. G. F. Hardy, who had also been practically concerned in such work, to close it. The Institute were honoured by the company of Dr. Dudfield, who had read a paper on the subject, and he hoped he also would speak.

Mr. A. F. BURRIDGE said that Mr. Ryan had presented in his paper, in a serviceable shape, a *résumé* of Census literature, not only of this country but of foreign countries also. The amount of reading which a man had to go through in order to arrive at the heart of the subject, and to present its essence in the highly condensed and concentrated form in which it could be perused in the paper, would be realized by a glance at the list of references which formed such a commendable addition to a paper of that character. The English blue-books, and the writings of statisticians in England and in foreign countries, had all to be consulted. Speaking broadly, the main impression left on one's mind by reading the paper was one of disappointment—disappointment at the backward methods of Census-taking in this country. That was a matter that had been put forward very plainly by the author. To those unacquainted with the subject that would, perhaps, come as a revelation. But to those who held the opinion that the question of accurate scientific data was one of national importance, the feeling produced by observing the present condition of things was one bordering on humiliation. He would mention two examples, which were both drawn from the paper, of the state of affairs produced by our present methods. The first case had reference to the errors between the estimated and the actual populations in large towns. Of course, if the populations of large towns would condescend to follow something like a steady and orderly progression or diminution, the matter would be simple. But those populations, from social or other causes, did nothing of the kind. They advanced very often by fits and starts, and the result was that the evidence shown by the Census Committee of 1890 was to the effect that in many large towns the real population, as disclosed by the Census, exceeded the estimated population by 16 per-cent, 18 per-cent, or 25 per-cent. Other populations took an opposite direction, and fell below the estimate. He wished to ask how it was possible, in that state of affairs, for Officers of Health, and others responsible for similar duties, to compile correct estimates of the vital statistics of our large masses of population. The second case was that mentioned by Mr. Ryan in regard to Eastbourne Corporation Stock. It had been estimated that the population of Eastbourne would largely exceed the 50,000 required in order to bring that Stock within the Act of 1893. But the real facts, as disclosed at the Census, were that the population enumerated was 43,000, an

error of large percentage. These, to his mind, were two striking examples of the defects—the necessary defects—of the present antiquated system of Census-taking. There were first the errors in the estimated populations of the towns, and, proceeding from that, the disorganization of municipal finance, as disclosed in the Eastbourne case.

He would next turn to the other side of the picture, and glance at some of the remedies which had been suggested, with remarkable unanimity, by statisticians in various societies. In the first place, there was the evidence of the Census Committee of 1890. Members would well remember that the Royal Statistical Society, for many years, as their respected Fellows, Mr. Bailey and Mr. F. Hendriks would tell them, had memorialized successive Governments with the view of obtaining those necessary reforms. The Census Executive themselves were very much impressed in the same direction. Then their own Institute memorialized the Government quite recently. The suggestions which had been made for reform of the Census all took the same direction. Mr. Ryan had summarized them, and they were seen to fall very much within the lines of those recommended by the memorial which emanated from the Council. If he merely read their heads, it was because their importance had been enunciated over and over again by the highest authorities in statistical matters. One might take them in a summary order: That there should be a Quinquennial Census; that there should be a Permanent Census Department; that that Department should be governed by a permanent Census Law; that the schedules should be abstracted by the use of cards—nay, better still, by the use of machines; and lastly, that the population should be enumerated in the individual ages, and not in a curious assortment of quinquennial and other groups. He would not occupy the time of the meeting in elaborating any of those points; they did not require his advocacy, as they were supported by all high statistical authorities who had studied the subject. Before concluding, he wished to say a few words upon one or two points of interest and novelty in Mr. Ryan's paper, hitherto untouched upon. First, with regard to enumerating machines, he thought the present was the first occasion on which the famous Hollerith machine had been introduced to the attention of the Institute. That was a machine which had been in use for many years in the United States; and they had it on the word of the Census Commissioner that it had been used with absolute and unqualified success and satisfaction. It was in use in Canada and Austria, it had been tested in the cities of Berlin, Paris, and Rome, and 70 of them were used in the Russian Census of 1897. But up to the present date, if he had been correctly informed, not one of them had yet made its appearance in the city of London. The Fellows of that Institute knew that the Census Executive themselves were asking for the help of that machine many years before the last Census; at least, one was led to believe so from the paper; and he would not be surprised if they should still be asking for it when perhaps some insurance or railway company had a Hollerith machine steadily at work in its offices.

For one was led to believe from the evidence that the machine contained possibilities, perhaps not yet fully developed, which might render it a desirable assistant in railway accounts, and very probably in life assurance calculations also. An excellent point had been made by Mr. Ryan in drawing attention to the absence of text-books. He, in common with the rest of those who had looked into those matters, found an enormous increase of labour occasioned by the absence of volumes to which one could turn as standard books of reference. Mr. Ryan could not point to better examples than the publications of Levasseur and Bertillon. It might be interesting to future students of the subject to know that Bertillon's valuable book, with several other volumes bearing on the subject, would, in the future, owing to the kindness of Mr. Ryan, be found in the library of the Institute. In closing his remarks, he expressed the hope that it would not be too much to expect that the primary effect of that evening's work would be that a strong pronouncement would be made by the Institute in favour of an early reform in the English methods of Census-taking; and it might be hoped, as a secondary effect, that some student would be inspired by Mr. Ryan's suggestion to deal with what he could not help regarding as a very fascinating field of vital statistics.

Dr. REGINALD DUDFIELD thanked the Council for the invitation to be present. He felt some difficulty in speaking on the matter, because, when all were agreed, there was scarcely room for discussion. But there were one or two points which he might touch upon. The first had reference to the frequency of the Census. He had himself advocated that Censuses should be much more frequent; as Mr. Ryan said, one should be taken, at any rate every five years. There were two reasons for that. First, the increase in the facilities for rapid locomotion led to very rapid aggregations of population in new places. The examples mentioned by the author bore that out. Another consideration was the tendency in the present day for new lines of business to spring up with very great rapidity and develop enormously. Those two reasons alone, he thought, afforded good ground for having a quinquennial Census. He would like to refer to the case of Eastbourne, which he knew very well, as he was Medical Officer of Health there for $2\frac{1}{2}$ years, and he had not the opportunity of referring to the Registrar-General's returns. On looking at the note in Mr. Ryan's paper, he could not help thinking that a confusion had been made by the Town Clerk. At the time he (Dr. Dudfield) had to deal with figures of Eastbourne—*i.e.*, on the last occasion he had to refer to the matter at all—the estimated population of Eastbourne borough was not included in any return of the Registrar-General. That official always gave as the population of the borough the population of the registration district, which was a very different thing; and he could not avoid the belief that some mistake had been due to the Town Clerk having confused those two together. That could only be verified by reference to the Registrar-General's returns, to see if Eastbourne was among the hundred towns specified in his annual report. Mr. Ryan had also alluded to the question of areas. That subject, he thought, was dealt with in Mr. Byers' paper on the Census of 1891, wherein the author referred to the vast areas which

had been hitherto dealt with. Perhaps he (Dr. Dudfield) was illustrating the adage, "every cobbler to his own trade", but, having regard to the fact that sanitary officials made more use of Census returns than perhaps any other profession, he thought the sanitary area ought to be the area for everything. In all probability there would be before the House of Commons a Redistribution Bill. He thought the time had come when some effort should be made to have the multiplicity of areas so adjusted as to make it easy to progress from the unit sanitary authority up to the whole United Kingdom. Two other points he wished to allude to were—the mode of obtaining information, and the confusion of the sexes. The two things should intermingle, because he was strongly in favour of the card system, not only in the office, but for obtaining information. During the last summer he had had occasion to make an enquiry, involving the enumeration of the population of a small area in his borough. It only meant 8,000 people, but it involved a house-to-house visitation and the actual counting of the people, a determination of their ages, occupations, how long they had been there, and their wages, as well as what rents they paid. He found that by the use of two cards—one of which he called the "house" card, and the other the "home" card—it had been not only easy to get the information straightforwardly, and in a manner which could be checked, but the work of tabulation had been very easy. He had had to do it himself, but it had not proved a very difficult task. He thought if, instead of the cumbersome double foolscap sheet of flimsy blue paper, it were possible to leave at each tenement or house a decent substantial card, which should be entered under the proper headings, to be checked by the enumerator when he came round—or even, as he would prefer it, filled up by the enumerator when he called,—and that card were sent up to Somerset House or the Census Office instead of being transcribed into the enumerators' books, the result would be better. He would touch on only one other point. A reference was made to the extent of the material which should be included in the schedule for enquiry. He did not know whether the members of the Institute were acquainted with the new Factory Act, which would come into force next January. In that was a section which, if properly used, contained great potentialities. He alluded to section 130, which empowered the Secretary of State, or, in his place, the Chief Inspector of Factories, to obtain from the employers of all labour which fell within the provisions of the Factory Acts, a return, not more frequently than once a year and not less than once every three years, of all the persons employed. It was left to the discretion of the Secretary of State, and if that section were properly fulfilled and worked by the Secretary of State, and his requirements were loyally carried out by employers of labour, there would be obtained, in a few years' time, a valuable mass of statistics with regard to employment in the Kingdom. With regard to the bibliography of the subject, there was one book which he was surprised had not been included—namely, Farr's *Vital Statistics*—which was issued by the Sanitary Institute a few years ago. He admitted that Farr's work was a little out of date, but anyone who read the book would find it immensely interesting and very instructive.

Mr. HOWARD J. BARNES said that, so far as he knew, the Hollerith machine had not been seen in this country. He well remembered the paper which was read at the Statistical Society when the machine was described. Dr. Hollerith mentioned that he had gone to some expense to bring one of the machines for exhibition, but the Customs Officials, thinking it a rather dangerous-looking machine, blocked it. But Dr. Hollerith said he hoped to get it back from the Customs Authorities in time to take it with him to America, for which country he was starting on the following day.

Mr. A. H. BAILEY, in answer to the President's invitation, said he had very little to add to what Mr. Ryan had said. The difficulty he had found occasionally was in the returns of the occupations in the schedule. A great deal more explanation was required. At present the Directors of the Bank of England, and the man who kept a small grocer's shop in a town in Scotland, were all classed as "Merchants", and so described in the schedule. The same criticism applied to other trades. He felt a great deal of interest in the subject, and was much obliged to Mr. Ryan for bringing it forward.

Mr. GEORGE KING said he would like to add his thanks to those of the gentlemen who had already spoken, to Mr. Ryan for bringing the question of Censuses forward, and for the way in which he had done so. His paper would be very useful to any who wished to study the subject, and he hoped the Council of the Institute would, in due course, take the question up, in order to put pressure on the authorities, and to see whether some reform could not be brought about, even though very much might not be done at once. Altogether, apart from a reform in the times and methods of taking the Census, he thought some few changes in the system of tabulation would add greatly to the usefulness of the figures. One point which had troubled him very much in making various investigations was the absence of the numbers of persons enumerated at the individual ages. That had stopped him in what he thought might have been a useful investigation; and it was no secret that the Old Age Pension Committee, on which he had had the honour to serve, had met with the same difficulty, but it was overcome by applying to the Registrar-General's Department, whence the analogous figures required were obtained. That showed that the matter was very important, but only two pages or so of print would set it right. It was scarcely worth while to speak of the other points which had cropped up, as his (Mr. King's) views agreed with those of the author, and of other speakers. There was the large question of a more frequent Census, and he quite concurred with what had been said regarding it. He thought one day the endeavour to get more frequent Censuses would succeed, but possibly not yet.

Mr. G. F. HARDY said he thought the Institute was to be congratulated on Mr. Ryan's choice of a subject, because the question of Census reform was not only one of national importance, but also of peculiar interest to actuaries. In the early days of actuarial science, their whole work was necessarily based upon statistics of the nature of Census returns, and returns of births and deaths; and it was only after actuaries had been at work for many years that they were able to gather the facts upon which to base

their tables from the records of their own experience. Even now the actuary still depended to a large extent upon Census returns for information as to the effect upon mortality of climate and occupation. The Institute was, therefore, indebted to Mr. Ryan for the opportunity of throwing its weight into the scale in favour of reform, both in the methods of taking the Census as well as in presenting the results. He fully concurred in Mr. Ryan's estimate of the value of the report of the Committee of 1890, and of the evidence it collected. Among the many reforms suggested by the Committee, and referred to in the paper, he thought it would be generally agreed that two were specially urgent. In the first place, that the Census in future should be quinquennial, and, secondly, that a Census Office should be established, with a permanent staff, placed under the direction of some person who should be not only keenly in sympathy with his work, but at the same time a trained statistician. With an institution of that kind, which would, of course, be intimately associated with the Registrar-General's Department, he thought, with Mr. Ryan, that most of the desired reforms would follow as a matter of course, and new departures would probably be made which might prove of the greatest utility. As to the quinquennial Census, that was a matter which should be pressed for, as the commencement of the century was a very suitable time for bringing about such a reform. The argument in favour of that change was put very forcibly in Mr. Ryan's paper, both from the point of view of increased accuracy in the data obtained at the enumeration, and also from the standpoint of avoiding the erroneous deductions from the statistics which, under the present system, he had shown were so liable to occur. A further objection to the present system of decennial Censuses was the resulting delay. Important movements of the population or of trade were frequently taking place, as Dr. Dudfield had pointed out, with great rapidity, and it was important that they should not have to wait ten years before they had information of such movements, and in the meantime be in danger of making deductions from erroneous estimates, instead of from actual facts. He thought this single point of a quinquennial, rather than a decennial, Census was one on which the Institute was specially qualified to speak, and on which it might well concentrate its attention officially. It might be useful for the Council of the Institute to urge that one point, at any rate, upon the attention of the Government, and so assist in bringing about a Census in 1906. In the meantime, with respect to estimated populations in inter-Census periods, some less rigid method of estimate was required than that of an assumption of a geometrical rate of change based upon the rate of the previous ten years. There was no sufficient reason, where a borough like West Ham, between 1881 and 1891, increased at the rate of 58 per-cent in a decennium, to assume that a similar proportionate increase would be maintained during the following decennium. Where the main element in the movement of population was that of migration; in other words, where the rate of change departed widely from the normal, either in a positive or negative direction, the assumption of a geometrical rate was unsuitable. Dr. Dudfield had referred to the question of Census areas, and

had suggested that the basis for all purposes should be the sanitary areas, and he (Mr. Hardy) regarded that as a very suitable arrangement. What should be aimed at was, that the areas adopted should be as far as possible homogeneous as to the general character and density of the included population, as averages and ratios based upon heterogeneous data were misleading. A further reform which they might expect to follow from the establishment of a permanent Census Office was a more scientific treatment of the data generally. The adoption of the card system, which he regarded as a necessity, would enable the officials to investigate the nature and extent of the errors in the recorded data, for example, in the ages and occupations. Observations in statistics, as well as in every other science, were subject to errors of one class or another. They might be "accidental" errors due to the paucity of the data, or "systematic" errors, due to erroneous statements of fact. The former did not affect Census or registration returns, in which the facts were very numerous, but those returns were affected seriously by the latter class of "systematic" errors, due to erroneous statements by the persons from whom the information was collected. Those errors, while they vitiated the returns as they were presented, were, however, themselves subject to law, as was every physical phenomenon, and a permanent Census staff, employing the card system and collating the data obtained at an enumeration with the corresponding information obtained by the Registrar-General, would be able, to some extent, to investigate the nature of the errors, especially in respect of ages and occupations, affecting both classes of returns. In that way one serious cause of error might be practically eliminated. In the case of some populations, such as that of India, where the errors in the recorded population at the various ages were very considerable, it was absolutely necessary to make some attempt to investigate the law on which these errors were based, or it would be impossible to deduce any trustworthy conclusions from the statistics.

The mode of presenting the statistical facts obtained was almost as important as the accuracy of the facts themselves. To refer only to one illustration out of many, namely, the present rough method of dealing with death-rates. All his hearers knew how erroneous it was to merely bring their minds to bear on the gross death-rate of a certain community, to say that the death-rate was 15 or 20 per thousand. That did not convey sufficient information to be of much use to anybody; and, as Bertillon said in his book, the least they ought to ask for was that a separation should be made between children, adults at the working period of life, and old people, taking as age groups, say, 0—20, 20—60, and over 60. It would be very simple to make a change of that kind. While it might be somewhat cumbersome to have to quote actual death-rates for each of those divisions of the population, it would be quite possible to adopt some short method, by the use of letters or cyphers, representing rates of mortality lying within certain selected limits for each of those three portions of the population. In that way, by the use of three letters or cyphers, one could have a clear index of the state as to health of a given community for each of the three important periods of life.

Among other points which a Permanent Census Office could take up was that of migration of the population, not only outside the country, but, as far as possible, within the country. The very incomplete nature of these returns at present seriously diminished their value. If the suggested Census Office were to take up that question, giving them a quinquennial Census, and collating where possible the data so obtained with those obtained by the Registrar-General, they would thus have a clear and comprehensive view of the state of the population at frequent intervals—from which the errors which now crept in would be practically excluded. In that way they would be put in possession of a body of statistics which would be of the highest value to actuaries, and to everyone interested in the progress and well-being of the community.

The PRESIDENT said that a proposal would be put before the next Council to establish another Census Committee of the Institute, to continue pegging away at anybody and everybody concerned until something in the direction of reform was accomplished. He hoped it would keep its eye on the Hollerith machine in case anyone managed to smuggle one in, and some public body or great assurance company should buy one. He hoped that Committee would also consider whether it was possible to prepare a model Census card, which might form a nucleus for the Census returns of all portions of the British Empire, so that in the same part of the card one would look for and find the same particulars, while there would be a special place for the special characteristics of the separate countries. It was a large matter, but if it was possible he thought the Institute could manage it as well as anybody else. The Government of India, following the precedent it established when it consulted Mr. G. F. Hardy as to previous Censuses, had been studying the Report of the Institute's last Census Committee. They had sent the Institute an excellent memorandum, showing how the particular characteristics of India bore upon recommendations there made, and they had asked the Institute whether they thought it desirable that certain statistics they could give of the Government establishment in India would be sufficiently useful to be worth tabulating and publishing. If so, they had asked how best to set about the task. The Council had answered to the best of their ability, and the papers were being sent to the editor of the *Journal*, so that the members might know what was going on. One point he trusted would not be forgotten in these Census matters. Not only was it necessary to see that everything was on the card which ought to be, but also that nothing was on it which ought not, so that needless expenditure of time and money in procuring superfluous details might be avoided. He would read a clause from one of the documents from India he had just referred to, and he thought all would agree that the words were words of wisdom:—"Without wishing to interfere unduly with the discretion of local governments in a matter of this kind, the Government of India are constrained to point out that there is a tendency to multiply statistics out of all proportion to the use that will ever be made of them. A Census offers special temptations to indulge in this tendency, and many of the statistics, which are compiled on such an occasion, are open to objection in two ways from the Imperial point of view. They cost

money in themselves, and they delay the completion of the Census Reports, both forms of expenditure being Imperial charges."

A vote of thanks was accorded to Mr. Ryan by acclamation.

Mr. RYAN, in returning thanks, said the striking feature of the discussion was the unanimity of view as to the desirability of reforms in our Census system, very much on the lines laid down in the paper. He hoped that that unanimity would encourage the Council of the Institute, the Council of the Statistical Society, and other bodies, to renew and repeat their representations to the Government, so that the object they had in view might be achieved. If by such means the date of reform could be accelerated, there would be little need to regret having devoted an evening to the discussion of the subject.

The Business Management of Foreign Life Insurance Companies according to German Imperial Law. By DR. KARL SAMWER.

THE Paper of Mr. H. R. Harding upon "Government Legislation in reference to the working of Life Assurance Companies"*, submitted to the First International Congress of Actuaries, the supplement added thereto by myself relative to German Law**, and my paper upon German Insurance Legislation for the Second International Congress***, show that the public Law relative to the business management of home and foreign Life Insurance Offices differed until recently in the individual German States, and in many of those individual States a firm basis was lacking.

The German Imperial Law of 12 May 1901, (^a) relative to private Insurance undertakings, put an end to this unsatisfactory state of affairs. Some of the conditions thereof (§ 70, § 98, clause 1, § 101, par. 3), came into force on 1 July 1901, in order to prepare for the exercise of the Government supervision according to the Law (§ 125, par. 1), the remaining provisions came into force on 1 January 1902 by virtue of the Imperial Ordinance of 24 November 1901.

On this date all regulations published, or merely administered in practice by German individual States, for the admission and supervision of Life Insurance Institutions are superseded. Henceforth, one Government supervision, and that only by the

* Premier Congrès International d'Actuaires Documents (Brussels: Bruylant-Christophe & Co., 1896), No. 8, pp. 1-38.

** *Ibid*, No. 8, pp. 47-49.

*** Transactions of the Second International Actuarial Congress (London: Charles and Edwin Layton), 1899, pp. 261-268.

Imperial Government, will be exercised over the large German Life Insurance Institutions, and over all foreign Life Insurance Institutions working in any part of the German Empire (§ 6, par. 3).

Fundamentally, the foreign Companies are subject to the same Law as the German. To this, however, exceptions are made, partly expressly (§§ 86-91), partly arising from the construction which establishes that a provision only refers to German Institutions. For § 85, par. 2, states that the provisions of the Law apply "in like manner" to foreign Insurance undertakings. In individual cases opinions will probably differ as to whether and to what extent a provision is to apply to foreign Companies.

In the following survey of the obligations imposed upon foreign Life Insurance Companies by the Imperial Law, I am not able to enter into every detail, but I will endeavour to set forth what is of practical importance.

Every foreign Company seeking to effect Insurances in the German Empire, not merely by correspondence, but through representatives or agents, must obtain a concession (*Erlaubnis*, *Zulassung*, § 85, par. 1). If, on 1 January 1902, it is already entitled to carry on business in one or more of the German individual States by virtue of a special concession, or by virtue of Laws rendering special concessions unnecessary,† it needs no fresh permission to continue business in the particular district specified by the special concession, or, in so far as the Law of the individual State permitted the transaction of business without a concession, in the district within which it has operated hitherto (§ 92). Nevertheless, it is permitted to apply for the Imperial concession (§ 96, clause 1), and it will, in this, do well if it desires to be free from the onerous conditions of special concessions, or if the license of the individual State has been granted with power of revocation (§ 95), the Imperial concession, however, would not be subject to spontaneous revocation by reason of the conditions of International Law.

The Company must apply for the Imperial concession if the special permission expires (§ 94, par. 1), (^b) or is revoked by the Imperial Supervision Department for private Insurance (§ 95), or if the office widens its scope of operations as to its nature or extent (§ 92), and in particular, if it desires to open up in

† For example, in Hamburg.

another individual German State (§ 96, clause 2). Further, any Company which proposes to begin Insurance business in the German Empire, or any part of it, after 31 December 1901, must obtain the Imperial concession (§ 85, par. 1).

The application for the Imperial concession must be made to the German Reichskanzler (§ 86, par. 1), ^(c) and therewith must be sent the scheme of the business, "*Geschäftsplan*" (§ 85, par. 2, § 4, par. 2). This must set forth clearly the object and purpose of the undertaking, the territorial sphere of the intended business, and such particulars as will show the possibility of continued fulfilment of the future obligations of the undertaking (§ 4, par. 2); it must contain particulars of the constitution, the general conditions of Insurance, the technical bases (§ 4, par. 3), the principles for the disposal of funds not belonging to the policy reserve, and a statement as to whether the Insurance business is to be carried on solely direct or also by way of reinsurance (§ 8). In particular, the tariffs and the principles for the calculation of premiums and policy reserves must be fully set forth, the rate of interest used in the calculations, and the addition to net premiums, stated, and it must also be mentioned whether the premium reserves are calculated by net premiums or with a partial capitalization of the loading ^(d); the mortality tables are to be given, formulas are to be set forth for the calculation of premiums, and of reserves, for each class of Insurance, and to be explained by a numerical illustration (§ 11, par. 1, 2). If Insurances are undertaken at increased premiums, it is also to be stated whether and on what basis a special reserve is formed for them (§ 11, par. 3). In the case of a mutual office, the scheme of business must also contain the conditions as regards admission to membership (§ 20, clause 1), obligation to make additional contributions (§§ 24, 27) and distribution of surplus (§ 38, par. 2).

For the purpose of obtaining the Imperial concession the Company has also to show the Reichskanzler that at the chief office of the undertaking it can acquire rights in its own name, undertake responsibilities, sue and be sued (§ 86, par. 2, No. 2), and it must pledge itself to maintain a branch office within the German Empire, and to appoint an Imperial Chief Attorney, residing in the Empire (§ 86, par. 2, No. 3, clause 1), and responsible for the fulfilment of all the legal obligations of the Company (§ 88).

The Reichskanzler hands the scheme of business to the Imperial Supervision Department for Private Insurance (Kaiserliches Aufsichtsamt für Privatversicherung, § 70), so that the latter may give an opinion after hearing the Insurance Counsel (Versicherungsbeirat, § 72), as to whether the scheme of business contravenes provisions of the Law, or the interests of the insured are not sufficiently protected, or the continued possibility of fulfilment of the obligations arising from the insurances is not satisfactorily provided for, or facts exist which justify the view that the business will not be conducted conformably to Law and good practice.

If the opinion of the Supervision Department causes no suspicion in this direction, and the other requirements above mentioned are fulfilled (§ 86, par. 2, Nos. 2, 3), the Reichskanzler is at liberty to grant the Imperial concession (§ 86, par. 2). He must give it if international arrangements are in favour of the foreign company (^e), otherwise he may refuse it, as then the decision is left to his unfettered judgment (§ 86, par. 3), so that the German Empire can deal with other countries on the principles of reciprocity. In all cases the concession may be made dependent upon a deposit being lodged (§ 7, par. 2).

If the Company is admitted by the Reichskanzler, the appointment of the Imperial Chief Attorney is published *ex officio* (^f). The Imperial Chief Attorney causes the branch office to be registered in the Commercial Register (compare § 30, par. 1, and Commercial Code of 10 May 1897, § 29, § 13), and gives notice of the commencement of business to the Governments of those individual States in which his Company desires to effect insurances (§ 115, par. 1). District Chief Attorneys are to be appointed at the request of the individual States (^g), and their power of Attorney is more restricted than that of the Imperial Chief Attorney (§ 86, par. 2, No. 3, clause 2), (§ 115, par. 2, clause 5). All the Agents—as well as the Imperial and District Chief Attorneys, if they at the same time carry on an Agency—must notify the Department competent according to the law of the individual State on taking up their Agencies (Imperial Trade Ordinance of 21 June 1869, § 14, par. 1, clause 1); and in so far as the conduct of their occupation goes beyond the extent of retail trade, they must further see that they are registered in the Commercial Register (Commercial Code, 10 May 1897, § 1, par. 1 and par. 2, No. 7, § 4, par. 1, § 29). The Company may be sued with reference to claims arising from its German

insurance business in the Court in whose jurisdiction the German branch office is situated, or the district chief representative concerned resides (§ 89, § 115, par. 3).

Those Companies which, by virtue of special concessions, or by virtue of special legal conditions which have hitherto exempted them from concessions, are entitled to carry on business, must make the necessary statements for the explanation of their plan of business to the Imperial Supervision Department for private Insurance by the 15 August 1901 [§ 98, clause 1, Notification of the Supervision Department of 10 July 1901, in the *Reichsanzeiger* (Imperial Gazette) of 13 July 1901]. If they have neglected this, the Supervision Department may, to compel the notification, threaten them with a penalty not exceeding 1,000 marks, and in case of non-compliance, carry the threat into execution (§ 98, clause 2; complaint, § 76). So long as they carry on business without the Imperial concession they need appoint no Imperial Chief Attorney, but must, upon the request of the individual States, in accordance with § 115, par. 2, appoint District Chief Attorneys. The jurisdiction of the State in which the District Chief Attorney is domiciled (§ 115, par. 3) applies also to themselves.

All foreign Companies which do not confine themselves to transacting business by correspondence, must make insurance contracts with persons whose customary place of abode is in the German Empire, only through representatives residing in the German Empire (§ 87). A printed copy of the general conditions of insurance, and, in the case of a Mutual Office, a copy of the constitution or articles of association, is to be handed to a proposer in the German Empire *before* the completion of the insurance contract, in exchange for a form of receipt to be specially prepared ^(h) (§ 10, par. 1). A copy of the accounts and annual report is to be given to every German policyholder at his request (§ 55, par. 3). A foreign Company may vary the general conditions of insurance *to the prejudice* of a German applicant for insurance only upon justifiable grounds, and only on condition that *before* the completion of the insurance the attention of the applicant is expressly (either verbally or in writing) directed to the variation, and he has declared in *writing* that he consents to the variation (§ 9, par. 3).

Further, every Company has to obtain the consent of the Supervision Department before it alters its plan of business (§ 13) or transfers its risks wholly or in individual portions to any

other Office (§ 14), or if it desires to obtain real property in the German Empire. The consent is unnecessary only in the case of the purchase of the property on the security of which it has invested, in the case of proceedings for compulsory sale by auction (§ 54). It must furnish to the Supervision Department its yearly statement of accounts and an annual report (§ 55, pars. 1 and 2), and, when requested, statistical information also. If an Office becomes insolvent or over-indebted, this is to be notified to the Supervision Department (§ 68, par. 2). If a Company goes into liquidation, it must accept no new insurances (§ 46, par. 3, Commercial Code of 10 May 1897, § 298, § 149).

The Law secures the claims of German policyholders by ordering that, in case of the failure of a foreign Company, those claims shall be first satisfied out of the policy reserves set aside for the insurances effected in the German Empire (§ 90, par. 1, § 61, par. 2-3, § 62). In order to make this right effectual, the Law requires from the Companies admitted after 31 December 1901, that they shall calculate and show in their books separately, according to the several classes of insurance, the German policy reserves in accordance with the scheme of business for the close of every financial year (§ 56, par. 1, for reassurances compare § 58); that they shall cause the correctness of the calculation to be certified at foot of the balance sheet by an expert (§ 56, par 2, clause 1), and that they shall carry an amount corresponding to the calculation to the German policy reserve fund, and represented by sound German securities⁽ⁱ⁾ (§ 57, par. 1, clause 1, § 59, § 60). These securities are to be entered in a register, a certified copy of which is to be submitted annually to the Supervision Department (§ 57, par. 3).

They form the German policy reserve fund, are to be dealt with separately from all the other property of the Company, and are to be kept, in a manner to be notified to the Supervision Department, at the Office of the German Branch, or, with the consent of the Supervision Department, in some other place in the German Empire (§ 57, par. 2; for Reassurances, compare § 58). The Company must so secure the German policy reserve fund, according to more precise regulations of the Supervision Department, that it can only be disposed of with the consent of the latter (§ 90, par 2). This can, for example, be effected as regards mortgages by registration in the register of land, and, as regards obligations of the German Empire or a German individual State, by registration in the ledger of the Empire or of

the individual State concerned ; the basis of the Bill (p. 48) points primarily to an agreement between Supervision Department and Company. Withdrawals from the German policy reserve fund may take place only in so far as the management of the funds in accordance with regulations makes them necessary, or the funds are released by the termination of the insurance obligations (§ 61, par. 1).

For Insurance Offices already entitled before 1 January 1902 to do business, the same regulations respecting policy reserve hold good for insurances effected after 31 December 1901 in the German Empire (§ 99, par. 1). The policy reserve for the older German insurances is to be separated until 1 January 1905 from the other funds, to be carried to the German policy reserve fund, and to be kept and managed therewith (§ 99, par. 2). Also until 1 January 1907 the reserve of the older German insurances is to be invested in the German securities approved by § 59, in so far as the Supervision Department does not make exceptions (§ 99, par 4).

And besides, for Mutual Offices the Law contains other regulations, among which is to be specially noted that the premiums of the policyholder, and the payments of the Office on similar hypotheses, are to be measured only on similar principles (§ 21, par. 1), that against the right of the Office to the premium the policyholder cannot set off a contra-account (§ 26), and that additional payments may not be called for except for the purpose of meeting the insurance claims (§ 24, par. 2, clause 2).

In the interest of the German policyholders obligations are imposed upon the Companies by the Law. In order that they may be fulfilled the Law threatens penalties for an offence against important regulations, and introduces a uniform Imperial supervision. Although as regards the admission of foreign Companies, as distinct from German, the Reichskanzler has a power of decision, yet the supervision, like that over the larger German Offices, is exercised by the Imperial Supervision Department for private insurance (§ 91, par. 1). However, there arises from the nature of things an actual difference, in so far that the Supervision Office can superintend the entire conduct of German Offices, but of foreign Offices, in the main, only the German management. Nevertheless, the foreign Companies are also bound to furnish to the Supervision Office explanations and information as regards the business beyond the German Empire. As an alteration of the plan of business intended only for extra-German territory may

react on the German policyholders, it also must be submitted to the Supervision Office for approval (§ 13).

The Supervision Department has to take note that the contracts are carried out according to the plan of business, and that the laws are observed in the interests of the policyholders, and in particular that the financial position of the Company is sound (§ 64, par. 1). For this purpose important measures of the Company are subject to its approval (Alteration of Plan of Business, § 13; Cession of Risks to another Office, § 14, § 73, par. 1, No. 2, 3; Recourse, §§ 74, 75; Purchase of Real Estate, § 54, par. 1; Dealings with German Policy Reserve Fund, § 90, par. 2), and an examination of the conduct of business and of the financial condition is permitted at any time (§ 65, par. 1). The Department may inspect books, documents, and papers in the business premises of the Imperial Chief Attorney, of the District Chief Attorneys, and of the Agents, and require information from these persons (§ 65, par. 2; Complaints, § 76). The continued control over the conduct of the business is facilitated for the Supervision Department by its power to issue precise regulations as to the form and manner and time for producing the annual statements of accounts and the annual report (§ 55, par. 2, 4; compare § 114, clause 2).

If the Supervision Department is in any doubt it will obtain explanations from the Company, dealing with the latter in a friendly spirit, and giving suggestions and advice of every kind (Basis of the Bill, p. 23). If need be, it may make such arrangements for the removal of improprieties as may appear to it suitable (§ 64, par. 2), and threaten penalties up to 1,000 marks for their enforcement, proceeding to recover them in the case of non-compliance (§ 64, par. 3, § 73, par. 1, No. 6, recourse §§ 74-75). It may require of the Company that the latter shall, within a specified period, alter doubtful business principles, or remove other defects, temporarily discontinue payments, and in particular, divide no profit, and neither buy up nor lend upon insurance policies (§ 69, par. 1, § 73, par. 1 No. 9, recourse §§ 74-75, compare § 100). Following the English method the Supervision Office is even entitled to reduce the claims in respect of current German insurances by at most one-third, so that the bankruptcy of a Company in difficulties may be avoided in the interests of the German policyholders (§ 69, par. 2, § 73, par. 1, No. 9, recourse §§ 74-75).

In extreme cases, the Supervision Office may wholly or partly

forbid the Company to transact business in Germany (§ 67, par. 1, § 73, par. 1, No. 7, recourse §§ 74-75), and take measures for the security and in favour of the German policyholders (§ 67, par. 2, complaint § 76). If a foreign Company has been admitted by a German individual State before 1 January 1902, with reservation of the right of revocation, the Supervision Office is entitled to exercise the right of revocation (§ 95, § 91, par. 1). Besides this, however, the German Federal Council (Bundesrat) is entitled, for the purpose of any necessary retaliation, to use its judgment, on the application of the Reichskanzler, in forbidding any foreign Company to transact business (§ 91, par. 2) if international arrangements do not prevent.

In those cases in which an Office voluntarily or compulsorily gives up business in the German Empire, the winding-up of the German insurances is to be subject to the supervision of the Supervision Department (§ 66, compare § 104).^{k1} To the latter the Company must also apply in order to withdraw a deposit which it has lodged before 1 January 1902 with a German individual State, or later on, with the Empire (§ 97, par. 1). Those foreign Companies which were doing business in German individual States before 1 January 1902, without State supervision, and which in the German Empire, from 1 January 1902, only collect the premiums for insurances already existing, but do not complete any new insurances, are not subject to the supervision of the Imperial Supervision Department.

For the Imperial supervision German and foreign Companies have to pay a tax (§ 81, par. 2-4), which is not to exceed 1 per mille of the premiums collected during the last financial year for insurances effected in the German Empire, after deducting any surplus or share of profit returned.

If a comparison be made between the positions of home and foreign Companies under the German Imperial Law, it will be seen that they are similar in essential points if, as regards foreign Companies, the freedom of action in the matter of admission and prohibition of conduct of business be excluded by International Law. If this is not the case the foreign Company is legally in a more unfavourable position, but actually only when its home State gives the German Empire grounds for retaliation.

In Germany the conviction has gained ground more and more that publicity is not sufficient to protect the interests of policyholders unskilled in business, and that only Government supervision can really attain this end. Solid undertakings need

not fear this—those unsound must fear it. Hence the majority of German Insurance Offices are in accord—except in matters of detail, such for instance as the introduction of the unnecessary District Chief Attorneys—with the Imperial Law of 12 May 1901.

How the Law will really work in practice depends upon whether the Supervision Department will employ the discretionary powers entrusted to it in a proper manner. That this may happen is the general desire.

(*a*) The sections quoted hereinafter without a reference relate to this Law. Editions have appeared with explanations by Professor Dr. Hermann Rehm (Munich: C. H. Beck, 1901), by Oberlandesgerichtsrat H. Könige (Berlin: J. Guttentag, 1901), by Dr. C. Neumann (Berlin: Verlag der Zeitschrift für Versicherungswesen, 1901), and by others. In the Imperial Gazette (Reichsgesetzblatt), 1901, No. 50, there has appeared under No. 2,824 an Imperial Ordinance of 23 December 1901, relative to the procedure and business administration of the Imperial Supervision Department for Private Insurance.

(*b*) If a special concession expires between 1 January and 1 July 1902, its duration is treated as extended for a year (§ 94, par. 2), so that the Company may obtain the Imperial concession in due time.

(*c*) Also in the case of the extension of its business by a Company authorized by special law or special concession to any other individual German State, although § 96, clause 2, seems here to prescribe the permission of the Imperial Supervision Department for private insurance. § 96, clause 2, refers to German Offices; for foreign Offices § 86, par. 1 applies the more so, as the law treats territorial extension as commencement of business.

(*d*) § 11, par. 1, clause 2, directs for German Offices that a Company which does not propose to make a full net premium reserve must in calculating its reserves only capitalize loading in so far, that the abatement in the net reserve when the insurance is completed shall amount at most to 12½ per mille of the sum assured. It is doubtful how this condition may apply to foreign Companies. The latter will, in my opinion, having regard to § 90, par. 1, be bound as to the reserve for German insurances by the maximum of 12½ per mille. Compare § 100.

(*e*) Foundation for the submission of the Bill to the Reichstag, 1900, p. 48: "Freedom of opinion is naturally restricted in so far as international arrangements allow more extended rights to foreign insurers for the conduct of their business in the country." Compare the commercial treaty of the German Empire with Austro-Hungary of 6 December 1891 (Deutsches Reichsgesetzblatt, 1892, p. 3, and subsequent), Article 19, par. 5. "Limited Companies, sleeping partnerships with share capital, and Insurance Companies of any kind legally existing in the territory of one of the contracting parties shall be permitted to carry on business and prosecute their rights before the Courts in the territory of the other party subject to laws and regulations there valid." This condition holds good according to notification of the Reichskanzler of 11 June 1901 as regards commercial relations with the British Empire (Deutsches Reichsgesetzblatt 1901, p. 205) also in favour of Great Britain.

(*f*) Report of the VII Commission (of the Reichstag) relative to the Bill respecting private insurance undertakings, p. 118.

(*g*) This is disputed by some because a foreign Office must previously appoint an Imperial Chief Attorney. But the Imperial Chief Attorney of the foreign Company has the position which the President of a native Company receives. Although a German Office in the German Empire has a President who manages the business it may be compelled to appoint District Chief Attorneys. Hence the

foreign Company, in spite of the existence of a Chief Attorney for the Empire, cannot evade the request of individual States for the appointment of District Chief Attorneys.

(^h) The form of receipt may be printed on the fly-leaf of the declaration form, but must be *specially signed* so that the proposer be made aware of the fact that he is giving a receipt for the condition of insurance.

(ⁱ) The German policy reserve is, according to § 59, to be invested at the option of the Company.

1. (a) In sound mortgages, ground rents (*Grundschuld*), or annuities (*Rentenschuld*) on German real estate (Civil Code, § 1807, par. 1, No. 1). According to § 60, par. 1, the security may be accepted if the loan does not exceed the value of the first three-fifths of the real estate. The selling price, ascertained by careful enquiry, is to be taken as the value of the real estate, and in this only the permanent characteristics and permanent yield of the real property are to be taken into consideration (§ 60, par. 4). Building sites, unfinished new buildings not yet yielding rent, and real property not producing permanent income (*e.g.*, pits, quarries and mines) are excluded for the purposes of loans (§ 60, par. 3). As a rule the loan must be a first charge (§ 60, par. 2).
- (b) In obligations of the German Empire, or a German individual State, and in obligations registered in the ledgers of the German Empire, or of a German individual State (Civil Code, § 1807, par. 1, No. 2).
- (c) In obligations the interest on which is guaranteed by the German Empire, or a German individual State (Civil Code, § 1807, par. 1, No. 3).
- (d) In securities, especially debentures, in so far as they are declared by the German Confederate Council (*Bundesrat*) as proper for the investment of trust money (Civil Code, § 1807, par. 1, No. 4), and in obligations of any kind of a German Municipal Corporation, or of the *Creditanstalt* (Treasury) of such a Corporation if the obligations are redeemable on notice from the creditors, or are subject to regular amortisation (Civil Code, § 1807, par. 1, No. 4). Notification of the *Reichskanzler* of 7 July 1901 in the German Imperial Gazette, 1901, p. 263).
- (e) To the extent of one-tenth of the German policy reserve fund in securities in which, according to special regulations of German individual States, trust funds may be invested, and in such bearer bonds of German Mortgage Limited Liability Banks upon which the *Reichsbank* lends as first class (§ 59, par. 1, No. 1, clause 2).
2. In advances upon mortgages or securities, in which by No. 1 an investment may be made up to 75 per-cent of their nominal value, or, if their market price is below par, up to 75 per-cent of the market price (§ 59, par. 1, No. 2).
3. In loans on its own insurance policies according to the general conditions of insurance (§ 59, par. 1, No. 3).
4. With the consent of the Imperial Supervision Department in debt inscriptions of German School or Church Communities, if these debt inscriptions are either redeemable on notice from the creditors, or subject to regular amortisation (§ 59, par. 1, No. 4). The debt inscriptions of German Communal bodies referred to at this part of the law are also permitted by the notification of the *Reichskanzler* referred to above under No. 1 (*d*) *without* consent of the Imperial Supervision Department.
5. So far, as the investment cannot be made in the securities specified under Nos. 1-4, by temporary investment in the *Reichsbank*, or in a German *Staatsbank* of an individual State, or in any other German Bank, or German public Savings Bank declared by the Imperial Supervision Department to be suitable therefor (§ 59, par. 2).

The foreign Companies are also no longer bound in Prussia, as has hitherto been the case, to invest a part of the German policy reserve in German Government Securities. But if this obligation is imposed upon a Company before 1 January 1902 by a special concession the obligation must according to § 92 still remain, as German Government Securities are allowed by § 59, par. 1, No. 1 (§ 99, par. 4).

But the Company may free itself from the obligation if it obtains the Imperial concession (§ 96, clause 1).

REVIEW.

Institute of Actuaries' Text-Book, Part I. Interest (including Annuities-Certain). New Edition. By RALPH TODHUNTER, M.A. C. & E. Layton, Farringdon Street, E.C.

IN the preface, contributed by the President on behalf of the Council of the Institute of Actuaries, we are informed that "the Council, while recognizing the skill with which the first *Text-Book*, Part I, on Interest, had been written, felt that in some ways it might be made more suitable for the students for whom it was intended. When, therefore, a new edition was needed, they laid the matter before Mr. Todhunter, requesting him to consider it from this point of view." The author's primary object would thus appear to have been the production of a Text-book suitable for students preparing for the Institute of Actuaries' Examinations. It would be unfair, however, to regard Mr. Todhunter's book from this point of view alone. It is clear that, in the exercise of the discretion allowed him by the Council, he conceived a wider object than that indicated in their request. He has attempted to present a "comprehensive view" of the general theory of Compound Interest, and to illustrate the theory by applications to practical financial problems. In other words, he has endeavoured to give a complete exposition of the subject of Compound Interest, and in discussing his book, therefore, it is necessary to look at it from this point of view, as well as from that of the student.

It will be generally admitted that Mr. Todhunter has been on the whole successful, both in his own object and in carrying out the instructions of the Council. The plan of the book is admirable. The logical sequence of ideas in the treatment of the subject is especially noticeable, and proves how valuable Mr. Todhunter must have found his experience as a Lecturer. His book is not merely a student's book; it is also essentially a teacher's. The Lecturer for Part II of the Institute of Actuaries' Examinations who may succeed Mr. Todhunter will find one part of his task made easier; he need not go beyond Mr. Todhunter's book for his notes on Compound Interest.

Looking at the book in detail, we find it divides itself into the following sections: (i) Chapters I and II, which deal with elementary propositions and their application to some practical problems. (ii) Chapters III and IV, which are devoted to the Annuity-Certain. (iii) Chapters V and VI, which discuss the general evaluation of Debentures and other Securities and the

converse problem of the determination of the rate of interest involved in any transaction; and (iv) Chapters IX and X, which contain some formulas of the Differential and Integral Calculus and the Calculus of Finite Differences and their applications to questions of Compound Interest. The general discussion is interrupted by Chapters VII and VIII, the former of which deals with Capital Redemption Assurances, and the latter with the construction of Interest Tables.

Considering first the arrangement of these sections, it will be noticed that Mr. Todhunter has in one important point departed from precedent. Mr. Sutton and Mr. King, in their treatises on Compound Interest, have included the applications of the Calculus of Finite Differences in the chapters devoted to the discussion of the special parts of the subject to which the applications are made, while Mr. King, in Part II of the *Text-Book*, has adopted the same plan, both with regard to the Differential and Integral Calculus and the Calculus of Finite Differences. This arrangement, though perhaps preferable when the applications are so numerous as in Part II, is often confusing, and certainly, so far as the theory of Compound Interest is concerned, Mr. Todhunter's plan of relegating all the applications of the Calculus to a separate section at the end of the book seems much more satisfactory.

Taking now the separate sections in turn, we observe that in the first chapter we are introduced at once to the distinction between the nominal and the effective rates of interest, and to the idea of the *force* of interest. Nothing could be clearer or simpler than Mr. Todhunter's explanations, and the only criticism that suggests itself is whether Article 30—consisting of a page-and-a-half of formulas—might not have been omitted with advantage to the student, who might have been left to work the formulas out for himself. In the second chapter the practical problems are admirably selected and very neatly solved. Problem V is perhaps the most interesting of the series.

The two chapters on the Annuity-Certain are perhaps just a little over-elaborated, and (if that is possible) too complete. For example, Articles 36–45 in Chapter III, dealing with Figurative Numbers and Annuities of the n th order, are of scarcely more than theoretic interest, and although previous writers have thought it necessary to discuss the subject, it is really of very little importance in the theory of Compound Interest. The summary in Article 18 of this chapter (III) should prove useful to the student. In Chapter IV the idea of the sinking fund is constantly kept in view, and the distinction between the “remunerative” and the “reproductive” rates of interest made clear. Article 14 is specially good, and deserves careful study.

Leaving the Annuity-Certain, we come to the section of the book which is necessarily the most difficult, as it deals with what is the only complex part of the subject, namely, the valuation of debentures and other securities, and the determination of the rate of interest yielded by any investment. This section Mr. Todhunter may justly regard as a complete success. He has not shirked any of the difficult points of the subject; he has grappled boldly and thoroughly with all the problems that present themselves, and if the two chapters are

hard to master—as they are—it is because of the nature of the subject, and in spite of the excellent way in which it is discussed. Beginning with some preliminary explanations of a few points of an essentially practical character, Mr. Todhunter goes on to Makeham's Formulas for the valuation of redeemable securities, of which he gives an entirely satisfactory proof. He then considers the special points involved in the valuation of Consols, and other British Government Securities, the Sheffield Water Progressive Annuities, the "B" Annuities of Indian Railways, and American Railway Bonds, and the Debentures of Industrial Companies. Every point of any importance is carefully dealt with; for example, the question of income tax and the necessary adjustment which it involves. The formulas are then extended to the cases of securities redeemable not in one sum but by instalments: as, for example, Foreign Loans redeemable by annual drawings, of which the French Rentes and the Chinese Gold Loan of 1896 are selected as instructive illustrations. The fifth chapter concludes with some remarks on the consolidation of loans, and then, in the next chapter, Mr. Todhunter is ready to start with the problem of determining the rate of interest involved in any given transaction. Three methods of approximation are discussed—(i) without the aid of interest tables, by direct expansion of the algebraical expression involving the unknown rate, (ii) with the aid of tables by expansion of a modified expression got by substituting a rate very nearly equal to the unknown rate, (iii) with the aid of tables and by interpolation between the results yielded by two or more trial rates as in No. (ii). Of the formulas worked out by the first method, the only one which calls for notice is the

elegant and original formula $i = \frac{g - \frac{k}{n}}{1 + \frac{n+1}{2n}k}$ for the rate of interest

realized on a debenture redeemable in n years, carrying a dividend at the rate of g per annum (payable yearly) per unit of its redemption-price, and bought at a premium of k per unit on its redemption-price.

Altogether, over twenty formulas of approximation are obtained, some of them of a rather complex character, and they are brought together in a useful summary on page 121. So far as possible, Mr. Todhunter does his best to indicate throughout which formula would be the most suitable to apply in any particular case, and this point is made still clearer by the collection of examples with which the chapter concludes. Among these we may call attention to that of the Revenue Account of an Assurance Company (pp. 126-7), in which we find a proof of G. F. Hardy's well-known formula $i = \frac{2I}{A+B-I}$ approximately.

Chapter VII, on Capital Redemption Assurances, contains several interesting formulas, which will prepare the student for the discussion of Premiums, Policy-Values, &c., in Part II of the *Text-Book*. These Assurances have recently acquired considerable importance with many offices, and their practical aspects have formed the

subject of a paper read before the Institute (*J.I.A.*, xxxiv, 162). Mr. Todhunter's discussion of the theory is therefore useful, though it does not present any novel features of interest. We may mention here a practical point to which our attention has been called: namely, that the yield on a Leasehold can generally be increased by effecting an $n-1$ -year Policy at the end of the first year instead of an n -year Policy at the start.

Chapter VIII, on Interest Tables, is included, presumably, in order to make the book complete. The methods of construction of such Tables are described in detail, and a list of the most important Interest Tables in existence is added, with some account of the extent and special utility of each. The preparation of this list must have involved a considerable amount of research, for which Mr. Todhunter deserves our gratitude.

We have come now to the last section of the book, Chapters IX and X, which deal with the Infinitesimal Calculus and its applications. By mathematical students this section will probably be regarded as the best part of the book. No one who has not tried to coach for Part III of the old Syllabus of the Institute of Actuaries' Examinations can realize how difficult it is to pick out and to teach just those parts of the Differential and Integral Calculus, and the Calculus of Finite Differences, which the actuarial student requires. The ordinary text-books on the Calculus rely so much on the examples afforded by Trigonometry, with which very few actuarial students are acquainted, that they are practically useless from our point of view. In a single short chapter, however (Chap. IX), Mr. Todhunter has succeeded in including every theorem of the Differential and Integral Calculus which the actuarial student will require for his work. It is a triumph of selection, of which only an experienced teacher could have been capable. The whole chapter is good, but we need make special mention of only two points. First, the proof given of Maclaurin's and Taylor's expansions is simple, while it is sufficiently strict for our purposes. And again, the distinction between complete and partial differentiation is made much clearer by the use of a special notation.

In Chapter X—the last of the book—some applications are given of the Calculus of Finite Differences, and of the Infinitesimal Calculus. Among others we may notice those to *varying rates of interest* and to the *varying annuity*. The problems of the sixth chapter are also attacked again, with the aid of the Calculus, and Mr. Todhunter proceeds to find formulas which give the rate of interest involved in any transaction correctly to about six places of decimals. Surely such an approximation is sufficient for all practical purposes!

Altogether, Mr. Todhunter is to be congratulated on the result of his labours. In one or two minor points, it might be possible to venture on criticism. Thus, the freer use of different kinds of type here and there might have helped to indicate more clearly the relative importance of different articles. Or, again, the use of asterisks might have indicated to the student who is reading the subject for the first time what articles in each chapter he would do well to postpone till he has a firmer grasp of the subject. But these

are only details, after all, and can be remedied, if experience proves that they require to be remedied, when a second edition of the book becomes necessary. They do not, to any great extent, detract from the merits of the book, for which we owe Mr. Todhunter our warmest thanks.

A. L.

ACTUARIAL NOTE.

On the Calculation of Deferred Annuities.

By HOWARD T. ADLARD, F.I.A.

THE object of this note is to investigate a formula for the solution of the following problem, which shall be easy of application to individual cases, and at the same time sufficiently accurate for all practical purposes.

“To find the annual premium, at rate of interest i , for a deferred annuity-due on (x) to commence n years hence, all premiums paid to be returned, with compound interest at rate i , in the event of death occurring before the annuity commences.”

Now whatever method of solution be adopted, the required annual premium will always be of the form

$$\pi_x = \frac{\ddot{M}_{x+n}}{\ddot{N}_x - \ddot{N}_{x+n} - D_x \cdot X},$$

where X denotes “the present value of the amount to which an annuity-due will accumulate by the end of the year of death, provided death occur within the first n years.”

It will therefore be sufficient for our purpose to investigate a formula for obtaining the value of X .

The most obvious solution is that given by Messrs. Ackland and Hardy in their *Graduated Exercises and Examples*, page 87, as follows:—

$$\begin{aligned} X \cdot D_x &= (1+j)C_x + [(1+j) + (1+j)^2]C_{x+1} + \dots \\ &\quad + [(1+j) + (1+j)^2 + \dots + (1+j)^n]C_{x+n-1} \\ &= (1+j)M_x + (1+j)^2M_{x+1} + \dots + (1+j)^nM_{x+n-1} \\ &\quad - (1+j) \frac{(1+j)^n - 1}{j} M_{x+n} \\ &= \ddot{N}_x - \ddot{N}_{x+n} - D_{x+n}(s_{\overline{n+1}|} - 1) \quad \text{when } i=i. \end{aligned}$$

This formula, however, does not lend itself to the calculation of individual cases, as either the terms must be obtained separately

and summed, or a formula of approximate summation must be employed.

The following solution, suggested by Mr. R. P. Hardy (*J.I.A.*, vol. xxiii, p. 244), may in certain cases be usefully employed:—

$$\begin{aligned} X &= \sum_{t=1}^{t=n} v^t (1+j)^t \frac{(1+j)^t - 1}{j} {}_{t-1}q_x \\ &= \frac{1+j}{j} \cdot \frac{1}{D_x} [\{(1+j)C_x + (1+j)^2 C_{x+1} + \dots + (1+j)^n C_{x+n-1}\} \\ &\quad - \{C_x + C_{x+1} + \dots + C_{x+n-1}\}] \\ &= \frac{1}{D_x} \{N_x - N_{x+n} - D_{x+n} (s_{\overline{n+1}|} - 1)\} \quad \text{when } j=i. \end{aligned}$$

This formula, although well adapted to the construction of tables by the columnar method, becomes extremely laborious when applied to individual cases, but, as Mr. G. King has shown (*J.I.A.*, vol. xxiii, p. 249), it can be reduced to the following simple form:—

$$X = \frac{1+j}{j} \{A'_{xn} - A^1_{xn}\}$$

where A'_{xn} is calculated at rate $I = \frac{i-j}{1+j}$.

In this form, the value of X can be very easily computed, provided I is such a rate of interest as is to be found in ordinary tables, but it is very rarely that this will be the case, so that this formula is not of very great practical value.

Now it is well known that a very close approximation to the present value of the amount to which an annuity-due will accumulate by the end of the year of death, whenever that may occur, is given by the formula

$$(1+a_x)_{(i)} \cdot \frac{A_{x(i)}}{A_{x(j)}} \quad (\text{see } J.I.A., \text{ vol. xxiii, p. 254}).$$

It therefore seemed probable that a similar formula would give a sufficiently close approximation to the value of X .

In order to obtain such a formula it is necessary first to find the value of X , say X' , when $j=i$, which can, of course, be easily obtained by equating j to i in any of the expressions for X as given above. It is more satisfactory, however, to obtain it by a direct process, and this can be done very simply, as follows:

Let the present value of the accumulations of an annuity-due in respect of l_x persons living at age x be represented by Y , then we have—

$$\begin{aligned} Y &= d_x \\ &\quad + d_{x+1} + v d_{x+1} \\ &\quad + d_{x+2} + v d_{x+2} + v^2 d_{x+2} \\ &\quad + \dots \\ &\quad + d_{x+n-1} + v d_{x+n-1} + \dots + v^{n-1} d_{x+n-1} \\ &= (l_x - l_{x+n}) + v(l_{x+1} - l_{x+n}) + \dots + v^{n-1}(l_{x+n-1} - l_{x+n}) \end{aligned}$$

$$\begin{aligned} \therefore Y \cdot v^x &= \mathbb{N}_x - \mathbb{N}_{x+n} - l_{x+n} \{v^x + v^{x+1} + \dots + v^{x+n-1}\} \\ &= \mathbb{N}_x - \mathbb{N}_{x+n} - D_{x+n} \{s_{\overline{n+1}|} - 1\} \end{aligned}$$

$$\therefore X' = \frac{1}{D_x} \{ \mathbb{N}_x - \mathbb{N}_{x+n} - D_{x+n} (s_{\overline{n+1}|} - 1) \}$$

Thus the proposed approximate value of X will be—

$$\frac{1}{D_x} \{ \mathbb{N}_x - \mathbb{N}_{x+n} - D_{x+n} (s_{\overline{n+1}|} - 1) \} \frac{\Lambda_{x+n|i}^1}{\Lambda_{x+n|j}^1}$$

where $\Lambda_{x+n|i}^1$ is calculated at rate i , and $\Lambda_{x+n|j}^1$ at rate j .

This is a practical illustration of the formula “suitably substituted”, referred to in a “note” in connection with Problem IIA in Mr. H. W. Manly’s paper on “The Valuation of Staff Pension Funds.” (See *J.I.A.*, vol. xxxvi, p. 221.)

By substituting this value of X in the formula for π_x we have—

$$\pi_x = \frac{\mathbb{N}_{x+n}}{\mathbb{N}_x - \mathbb{N}_{x+n} - \{ \mathbb{N}_x - \mathbb{N}_{x+n} - D_{x+n} (s_{\overline{n+1}|} - 1) \} \frac{\Lambda_{x+n|i}^1}{\Lambda_{x+n|j}^1}}$$

and when $j=i$ this reduces to—

$$\frac{a_{x+n}}{s_{\overline{n+1}|} - 1}$$

which is obviously correct, being the annual premium for a deferred annuity-due when the element of mortality is entirely eliminated during the first n years.

The suggested formula is very easy to apply, and its accuracy is illustrated by the following table, which gives the accurate and approximate values for the annual premiums for deferred

annuities commencing at age 60, for ages at entry 25, 30, and 35 based on the H^M Mortality Table, with $i = .03$, and $j = .025$.

Age at Entry	ANNUAL PREMIUM FOR DEFERRED ANNUITY OF £1	
	Actual Value	Approximate Value
25	·176	·175
30	·225	·224
35	·295	·294

CORRESPONDENCE.

UNIVERSITY OF LONDON.

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE.

To the Editor of the Journal of the Institute of Actuaries.

DEAR SIR,—The following information may prove of interest to your readers.

The University of London, as you are aware, has been reconstructed, after many tentative suggestions, and I am happy to add that those characteristic and unique features have been preserved which have rendered its degrees a genuine object of ambition. The Senate has recently approved the proposed Curricula and Schemes of Examination in the Faculty of Economics, and students who desire to proceed to the degree of B.Sc. (Bachelor of Science) in Economics and Political Science (including Commerce and Industry) have now been officially advised upon the courses of study to pursue.

In the second and third years' courses, which are obligatory upon all Honours students, one of the subjects for examination which may be selected is "The History, Theory and Present Systems of Insurance."

The Director of the London School of Economics and Political Science informs me that this is the first occasion in the educational history of any country in the world on which the subject of Insurance has been included as a feature of the examination on which a degree depends.

May I venture to suggest to our students the great advantage of attending some of the lectures at the School, No. 10, Adelphi Terrace? The lecturers are able and experienced men in their different departments; the cost of each course is exceedingly moderate; and, for the convenience of students, the lectures are given during the evening hours.

Yours truly,

T. E. YOUNG.

ORIGINAL TABLES.

To the Editor of the Journal of the Institute of Actuaries.

DEAR SIR,—Annual Premiums, at H^M 3 per-cent, for Endowment Assurances on Two Joint Lives, are given in the following pages. The *Text-Book* graduation of the H^M Table has been adopted as most suitable for the present purpose, partly because the terms of duration are short as compared with whole life, but more especially for the reason that it follows Makeham's law, in virtue of which we can substitute two equal ages w for two unequal ages x and y : hence it is sufficient to tabulate the values for equal ages only. A simple inspection of the auxiliary Seniority Table enables us to make the substitution at once, and thus $P_{xy|\overline{n}|}$ can easily be found: *e.g.*, if $P_{30,45|\overline{20}|}$ is required; we have $x=30$ and $y=45$; then entering the table with 15 ($=y-x$) we find 9·889, which must be added to 30 ($=x$), giving 39·889 for the equivalent equal ages. Thus we have $P_{30,45|\overline{20}|} = P_{39.889,39.889|\overline{20}|}$,

Now turning to the Premium Table, we see that

$$\begin{array}{rcl} & P_{39,39|\overline{20}|} & = 5.080 \\ \text{and} & P_{40,40|\overline{20}|} & = 5.152 \\ & & \hline & & .072 \\ .072 \times .889 & & = \underline{\underline{.064}} \end{array}$$

$\therefore P_{39.889,39.889|\overline{20}|} = P_{30,45|\overline{20}|} = 5.144$ the premium required.

The Seniority Table was constructed from the relation

$$c^x + c^y = 2c^w,$$

and consequently applies with considerable accuracy down to age 20 (see *Text-Book*, Part II, page 210, § 37), while above age 27 it is rigorously correct.

The formula employed in calculating the Premium Table was

$$\frac{D_{x,x}}{N_{x-1,x-1} - N_{x+n-1,x+n-1}} - d,$$

the values being computed by us independently, and results duly compared. The proofs have also been carefully read over with the two manuscripts.

We have considered it unnecessary to tabulate the Single Premiums, as these can be so readily obtained from the Annual Premiums by means of Rothery & Ryan's Conversion Tables—*e.g.*: to find the Single Premium corresponding to the Annual Premium 4·752. Reference to Rothery & Ryan shows that 4·61990 corresponds to 4·750 (occupying the same position on the adjacent page). Then we have merely to add $\frac{2}{6} \times$ the constant 0·00029, say

·00010, to ·61990, giving ·62000, or 62·000, for the assurance per 100 as the Single Premium required.

We remain,

Yours obediently,

A. S. HUME.

W. STOTT.

Liverpool,

28 September 1901.

AUXILIARY TABLE,

For finding the two Equal Ages (w) which may be substituted for two Unequal Ages (x) and (y) as determined by the equation $c^x + c^y = 2c^w$ (see Text-Book, Part II, p. 210, Art. 37).

Seniority of Elder Life ($y-x$)	Seniority of Equal Ages ($w-x$)	Seniority of Elder Life ($y-x$)	Seniority of Equal Ages ($w-x$)
1	0·511	26	19·384
2	1·046	27	20·302
3	1·602	28	21·227
4	2·182	29	22·158
5	2·783	30	23·095
6	3·406	31	24·037
7	4·050	32	24·983
8	4·715	33	25·934
9	5·400	34	26·890
10	6·101	35	27·848
11	6·827	36	28·811
12	7·567	37	29·776
13	8·325	38	30·745
14	9·100	39	31·716
15	9·889	40	32·689
16	10·694	41	33·665
17	11·513	42	34·643
18	12·344	43	35·623
19	13·188	44	36·604
20	14·044	45	37·588
21	14·911	46	38·572
22	15·788	47	39·558
23	16·674	48	40·545
24	17·569	49	41·533
25	18·473	50	42·523

*Endowment Assurances for two Joint Lives (equal ages), Annual Premiums for 100, payable in n Years or at First Death.—
H^M 3 per-cent (Text-Book).*

Duration	5	6	7	8	9	10	11	12
Ages								
20 20	18·789	15·547	13·238	11·511	10·172	9·105	8·237	7·516
21 21	18·817	15·574	13·264	11·537	10·198	9·131	8·262	7·541
22 22	18·839	15·597	13·287	11·559	10·220	9·153	8·283	7·562
23 23	18·857	15·616	13·305	11·577	10·238	9·171	8·302	7·580
24 24	18·872	15·631	13·320	11·594	10·254	9·187	8·318	7·597
25 25	18·885	15·643	13·333	11·606	10·268	9·201	8·332	7·612
26 26	18·895	15·654	13·345	11·619	10·281	9·215	8·347	7·627
27 27	18·906	15·666	13·357	11·632	10·294	9·229	8·361	7·643
28 28	18·917	15·678	13·370	11·645	10·309	9·245	8·377	7·660
29 29	18·929	15·690	13·384	11·660	10·324	9·260	8·394	7·677
30 30	18·941	15·704	13·398	11·675	10·340	9·277	8·413	7·697
31 31	18·956	15·719	13·415	11·692	10·359	9·297	8·434	7·719
32 32	18·971	15·735	13·432	11·711	10·379	9·319	8·455	7·742
33 33	18·986	15·753	13·451	11·732	10·400	9·342	8·480	7·768
34 34	19·004	15·772	13·472	11·754	10·424	9·366	8·507	7·796
35 35	19·024	15·794	13·496	11·779	10·451	9·395	8·537	7·828
36 36	19·046	15·818	13·521	11·806	10·479	9·425	8·569	7·862
37 37	19·069	15·843	13·548	11·836	10·511	9·458	8·604	7·898
38 38	19·096	15·872	13·578	11·868	10·546	9·495	8·643	7·940
39 39	19·123	15·903	13·612	11·904	10·583	9·536	8·685	7·985
40 40	19·154	15·937	13·649	11·943	10·625	9·580	8·732	8·034
41 41	19·188	15·973	13·689	11·985	10·671	9·628	8·783	8·088
42 42	19·227	16·015	13·733	12·034	10·721	9·681	8·840	8·148
43 43	19·267	16·059	13·781	12·084	10·776	9·739	8·901	8·213
44 44	19·312	16·108	13·834	12·141	10·836	9·804	8·969	8·284
45 45	19·361	16·162	13·892	12·203	10·902	9·873	9·043	8·362
46 46	19·415	16·221	13·956	12·271	10·975	9·951	9·125	8·449
47 47	19·474	16·286	14·026	12·346	11·055	10·036	9·215	8·543
48 48	19·539	16·357	14·102	12·429	11·143	10·129	9·313	8·648
49 49	19·611	16·435	14·188	12·519	11·239	10·231	9·421	8·762
50 50	19·689	16·520	14·279	12·618	11·344	10·343	9·540	8·888
51 51	19·776	16·616	14·381	12·727	11·461	10·467	9·672	9·026
52 52	19·869	16·718	14·493	12·847	11·588	10·602	9·815	9·178
53 53	19·974	16·832	14·615	12·979	11·729	10·752	9·973	9·345
54 54	20·087	16·956	14·750	13·124	11·883	10·916	10·147	9·528
55 55	20·211	17·093	14·898	13·282	12·052	11·096	10·338	9·730
56 56	20·348	17·243	15·060	13·456	12·239	11·294	10·548	9·952
57 57	20·497	17·407	15·239	13·649	12·444	11·512	10·779	10·196
58 58	20·663	17·589	15·436	13·860	12·670	11·754	11·031	10·465
59 59	20·844	17·788	15·652	14·092	12·919	12·017	11·314	...
60 60	21·043	18·008	15·890	14·348	13·193	12·308	...	...

*Endowment Assurances for two Joint Lives (equal ages), Annual Premiums for 100, payable in n Years or at First Death.—
H^M 3 per-cent (Text-Book).*

Duration	13	14	15	16	17	18	19	20
Ages								
20 20	6·909	6·392	5·947	5·559	5·220	4·920	4·655	4·418
21 21	6·934	6·416	5·970	5·583	5·244	4·945	4·680	4·444
22 22	6·955	6·438	5·992	5·605	5·266	4·967	4·703	4·467
23 23	6·973	6·457	6·011	5·625	5·286	4·988	4·724	4·488
24 24	6·991	6·474	6·029	5·643	5·305	5·008	4·744	4·510
25 25	7·006	6·490	6·046	5·661	5·323	5·026	4·763	4·530
26 26	7·022	6·506	6·063	5·678	5·342	5·046	4·784	4·551
27 27	7·038	6·524	6·081	5·697	5·361	5·066	4·805	4·573
28 28	7·056	6·542	6·100	5·718	5·383	5·089	4·829	4·598
29 29	7·075	6·562	6·121	5·740	5·406	5·113	4·854	4·625
30 30	7·095	6·584	6·144	5·763	5·431	5·140	4·882	4·654
31 31	7·118	6·608	6·170	5·790	5·459	5·169	4·913	4·686
32 32	7·143	6·634	6·197	5·819	5·489	5·200	4·946	4·721
33 33	7·170	6·662	6·227	5·851	5·523	5·235	4·982	4·759
34 34	7·200	6·694	6·260	5·885	5·559	5·273	5·022	4·801
35 35	7·233	6·728	6·296	5·923	5·599	5·316	5·066	4·847
36 36	7·268	6·766	6·336	5·965	5·643	5·361	5·115	4·897
37 37	7·307	6·807	6·379	6·011	5·691	5·411	5·167	4·953
38 38	7·351	6·853	6·427	6·061	5·744	5·467	5·225	5·013
39 39	7·399	6·903	6·480	6·116	5·801	5·528	5·289	5·080
40 40	7·450	6·957	6·537	6·176	5·865	5·594	5·358	5·152
41 41	7·507	7·017	6·601	6·243	5·934	5·667	5·435	5·232
42 42	7·570	7·084	6·670	6·316	6·011	5·747	5·519	5·320
43 43	7·638	7·156	6·745	6·395	6·094	5·834	5·610	5·416
44 44	7·714	7·236	6·829	6·483	6·186	5·931	5·711	5·521
45 45	7·797	7·322	6·921	6·579	6·287	6·036	5·821	5·636
46 46	7·888	7·418	7·021	6·685	6·398	6·152	5·942	5·762
47 47	7·988	7·523	7·132	6·801	6·519	6·279	6·075	5·901
48 48	8·097	7·638	7·253	6·928	6·652	6·419	6·220	6·052
49 49	8·218	7·765	7·387	7·068	6·798	6·572	6·380	6·219
50 50	8·350	7·905	7·533	7·221	6·959	6·739	6·554	6·400
51 51	8·496	8·058	7·694	7·390	7·136	6·923	6·746	...
52 52	8·656	8·226	7·870	7·575	7·329	7·125	...	...
53 53	8·832	8·412	8·064	7·778	7·541	...	...	...
54 54	9·026	8·615	8·278	8·001	...	...	...	...
55 55	9·238	8·838	8·512	...	...	...	...	...
56 56	9·472	9·084	...	...	...	...	...	...
57 57	9·729	...	...	...	...	...	...	...

Endowment Assurances for two Joint Lives (equal ages), Annual Premiums for 100, payable in n Years or at First Death.—
H^M 3 per-cent (Text-Book).

Duration	21	22	23	24	25	26	27	28
Ages								
20 20	4.206	4.016	3.844	3.688	3.547	3.418	3.301	3.194
21 21	4.232	4.042	3.871	3.716	3.575	3.447	3.330	3.224
22 22	4.256	4.066	3.895	3.741	3.601	3.473	3.357	3.252
23 23	4.278	4.089	3.918	3.765	3.625	3.499	3.384	3.279
24 24	4.300	4.111	3.942	3.789	3.650	3.525	3.411	3.307
25 25	4.321	4.134	3.965	3.813	3.675	3.551	3.438	3.335
26 26	4.343	4.156	3.989	3.838	3.702	3.578	3.467	3.365
27 27	4.366	4.181	4.015	3.865	3.730	3.608	3.497	3.397
28 28	4.393	4.208	4.043	3.895	3.761	3.640	3.531	3.433
29 29	4.420	4.238	4.074	3.926	3.794	3.675	3.568	3.471
30 30	4.450	4.269	4.107	3.961	3.831	3.713	3.607	3.512
31 31	4.484	4.304	4.141	4.000	3.871	3.755	3.651	3.558
32 32	4.521	4.343	4.184	4.042	3.915	3.801	3.699	3.607
33 33	4.561	4.385	4.228	4.087	3.962	3.851	3.751	3.662
34 34	4.604	4.431	4.276	4.137	4.015	3.905	3.808	3.721
35 35	4.653	4.481	4.328	4.193	4.072	3.965	3.870	3.785
36 36	4.705	4.536	4.386	4.253	4.135	4.030	3.938	3.857
37 37	4.764	4.597	4.449	4.319	4.204	4.102	4.012	3.934
38 38	4.827	4.663	4.518	4.391	4.279	4.180	4.094	4.018
39 39	4.896	4.736	4.594	4.470	4.361	4.266	4.183	4.110
40 40	4.972	4.815	4.677	4.556	4.451	4.359	4.279	4.210
41 41	5.056	4.902	4.768	4.651	4.549	4.461	4.385	4.319
42 42	5.148	4.998	4.867	4.754	4.656	4.572	4.500	4.439
43 43	5.247	5.102	4.976	4.867	4.773	4.693	4.625	...
44 44	5.357	5.216	5.094	4.990	4.901	4.825	...	...
45 45	5.477	5.341	5.224	5.125	5.040	...	...	...
46 46	5.609	5.478	5.366	5.272	...	...	...	...
47 47	5.753	5.627	5.521	...	...	...	...	...
48 48	5.910	5.791	...	...	...	...	...	...
49 49	6.083	...	...	...	...	...	...	...

Endowment Assurances for two Joint Lives (equal ages), Annual Premiums for 100, payable in n Years or at First Death.—
H^M 3 per-cent (Text-Book).

Duration	29	30	31	32	33	34	35	36
Ages								
20 20	3·097	3·007	2·926	2·851	2·782	2·719	2·662	2·609
21 21	3·127	3·038	2·957	2·883	2·815	2·751	2·697	2·646
22 22	3·156	3·068	2·988	2·915	2·848	2·788	2·732	2·682
23 23	3·181	3·098	3·018	2·946	2·881	2·821	2·767	2·717
24 24	3·213	3·127	3·049	2·978	2·914	2·856	2·802	2·754
25 25	3·242	3·158	3·081	3·012	2·948	2·891	2·840	2·793
26 26	3·274	3·191	3·115	3·047	2·985	2·929	2·879	2·834
27 27	3·307	3·225	3·152	3·085	3·025	2·970	2·922	2·878
28 28	3·344	3·264	3·191	3·126	3·068	3·015	2·968	2·926
29 29	3·384	3·305	3·234	3·171	3·114	3·063	3·018	2·978
30 30	3·427	3·350	3·281	3·220	3·165	3·116	3·073	3·034
31 31	3·474	3·399	3·333	3·273	3·220	3·173	3·132	3·096
32 32	3·526	3·453	3·389	3·331	3·280	3·236	3·195	3·162
33 33	3·583	3·512	3·450	3·394	3·346	3·303	3·266	3·234
34 34	3·644	3·576	3·516	3·463	3·417	3·377	3·341	3·312
35 35	3·712	3·646	3·589	3·538	3·495	3·457	3·424	...
36 36	3·785	3·722	3·667	3·620	3·578	3·543	...	...
37 37	3·865	3·805	3·753	3·708	3·670	...	...	...
38 38	3·952	3·895	3·846	3·804	...	...	...	...
39 39	4·048	3·994	3·948	...	...	...	...	...
40 40	4·151	4·100	...	...	...	...	...	...
41 41	4·264	...	...	...	...	...	...	...

Duration	37	38	39	40	41	42	43	44
Ages								
20 20	2·561	2·518	2·478	2·442	2·409	2·379	2·353	2·329
21 21	2·599	2·556	2·517	2·482	2·450	2·422	2·396	2·374
22 22	2·636	2·594	2·556	2·522	2·492	2·465	2·440	2·419
23 23	2·673	2·632	2·596	2·563	2·534	2·508	2·485	2·464
24 24	2·711	2·672	2·637	2·605	2·578	2·553	2·531	2·512
25 25	2·751	2·713	2·680	2·650	2·623	2·600	2·579	2·562
26 26	2·793	2·757	2·725	2·697	2·672	2·650	2·631	2·614
27 27	2·839	2·805	2·774	2·747	2·724	2·703	2·686	...
28 28	2·889	2·856	2·827	2·802	2·780	2·761	...	...
29 29	2·943	2·912	2·884	2·861	2·840	...	...	...
30 30	3·001	2·971	2·946	2·924	...	...	...	...
31 31	3·064	3·036	3·013	...	...	...	...	...
32 32	3·133	3·107	...	...	...	...	...	...
33 33	3·206	...	...	...	...	...	...	...

Duration	45	46	47	48	49	50
Ages						
20 20	2·307	2·289	2·272	2·257	2·244	2·233
21 21	2·353	2·336	2·320	2·306	2·295	...
22 22	2·400	2·383	2·368	2·356	...	...
23 23	2·447	2·431	2·418	...	...	...
24 24	2·496	2·481	...	...	...	...
25 25	2·546	...	...	...	...	...

M. Henri Adan.

ALTHOUGH, in the Report of the Institute, which was presented to the Annual General Meeting, held on 3 June last, mention was made of the loss sustained by the actuarial profession through the death, on 9 May, of M. Henri Adan, President of the Association of Belgian Actuaries, it is fitting that a more personal notice should appear in this *Journal*.

M. Adan was born in Brussels, on 1 February 1830, and when he had completed his preliminary studies he entered for the Belgian Bar, in the University of Brussels, and took his degree of *Doctor Juris* on 12 August 1852. He, however, did not follow the legal profession, but, in 1855, accepted the post of Secretary to the Royale Belge Assurance Company, of which he became General Manager in 1864.

M. Adan was a prolific writer on assurance questions, principally on those connected with the life and the accident branches, and he did much to spread sound views on these subjects on the European Continent. His early training caused him to regard in their legal aspect the questions on which he wrote, and a good example of this characteristic is to be found in the valuable paper he contributed to the London Congress of 1898, entitled "On Legislation of various kinds relating to the Life Assurance Contract from the International point of view." The same remark applies to his writings on accident insurance, and, on account of his practical as well as of his legal knowledge, he exercised a great and beneficent influence on the legislation of his native country.

We cannot here give a list of the papers and reports which came from his pen, and, even were we to do so, no great advantage would be gained, as they would not be accessible to readers in the United Kingdom. He began to write early, but perhaps in his later years he did his best work, taking an active part in various Government Commissions appointed to prepare the way for insurance legislation, and in International Congresses convened on private initiative. Those members of the Institute of Actuaries who attended the first International Actuarial Congress, held in Brussels in 1895, will remember his commanding though genial presence, and the active share he took in that gathering.

M. Adan was elected a Corresponding Member of the Institute of Actuaries so long ago as 10 November 1868; he was the first President of the Association of Belgian Actuaries, and was

elected a Corresponding Member of the Institute of French Actuaries in 1897.

It is, perhaps, worthy of note that M. George H. Adan, the son of the subject of this brief memoir, has succeeded his father as General Manager of the Royale Belge, and has been elected a Corresponding Member of the Institute of Actuaries.

THE INSTITUTE OF ACTUARIES.

At the Sessional meeting, held at Staple Inn Hall, Holborn, on Monday, 25 November, Mr. C. D. Higham (President) in the chair:—

The President said that, before calling on Mr. Ryan to read his paper, he wished to mention that the Card Index to the *Journal* was now complete, and if any gentleman wanted a reference which he could not discover in the printed index, he would doubtless be able to find it by attending at the Institute, because the Card Index was compiled in the fullest possible way, and provision had been made for keeping it going in future. The Institute was very much indebted to Mr. Marks for his labours on it.

The portraits of his (Mr. Higham's) distinguished predecessors had now been arranged in chronological order. Unfortunately, however, the first was missing, that of Mr. John Finlaison, because the Institute had been unable to procure one of him, but the list was brought up-to-date by the amiable features of the ex-President, Mr. Manly, whose photograph had now been added. An effort was being made also to get together a gallery of portraits of the giants of the past—they would observe De Moivre, Francis Baily, and Joshua Milne, and there were others, he hoped, coming—and if any gentleman could help in that respect the Institute would be greatly indebted to him. The Council were willing to buy such portraits if the prices were within their means, and he said that with the more alacrity, because he had noticed that when one of themselves came across a portrait he generally bought it, and presented it to the Institute.

THE PATRIOTIC FUND.

In the *Journal* for April 1901 (vol. xxxvi, p. 85) an abstract of a correspondence between the President and the Royal Commissioners of the Patriotic Fund was given, in which it was intimated that the work of preparing the valuations was in progress. The Commissioners, subsequently, in their Thirty-ninth Report to the King, acknowledged publicly the professional assistance, and the due completion of the task undertaken by the Council has now to be recorded.

Full particulars of the assets and liabilities of each of the ten Funds which required Actuarial valuation were supplied by the Secretary to the Royal Commissioners of the Patriotic Fund, and a

Committee of Members of the Council was formed to deal with the matter.

The complete Report of the Committee, including valuation schedules for each of the ten Funds was forwarded to the Royal Commissioners of the Patriotic Fund on the 8 July. The following reply was received by the President:—

ROYAL COMMISSIONERS OF THE PATRIOTIC FUND,
53 CHARING CROSS,
LONDON, S.W.

15 July 1901.

SIR,—I am commanded by His Royal Highness the President of this Commission to convey to you and your colleagues on the Council of the Institute of Actuaries, and the Honorary Secretaries of the Institute His Royal Highness's thanks, and the thanks of the Patriotic Fund Commissioners for the very valuable actuarial report, dated 8th inst., which you have given upon the assets and liabilities as at the 31 December of Funds administered by this Commission.

I am to assure you that His Royal Highness and the Patriotic Fund Commissioners appreciate very highly the services you have thus rendered in an honorary capacity.

I have the honour to be, Sir,

Your obedient Servant,

(Signed) J. S. YOUNG, COLONEL,
Secretary.

C. D. HIGHAM, Esq.,
President,
Institute of Actuaries, Staple Inn Hall,
Holborn.

The full details have been published as Appendix B in the Parliamentary Blue Book, entitled "Report from the Joint Select Committee of the House of Lords and the House of Commons on Charitable Agencies for Relief of Widows and Orphans of Soldiers and Sailors", and dated 26 July 1901.

The President (Mr. Higham) appeared before the Commission, and was examined at some length with reference to the Report and valuation of the Funds. A full report of Mr. Higham's evidence is given in the above-mentioned Parliamentary Paper, and in the Report will be observed with satisfaction the Committee's appreciation of the value of the information they had received through the Council's action.

The Council were also requested to advise as to the possibility of increasing, by 1s. per week, the allowance to widows on three of the Funds. The Council replied that, upon investigation, the surplus in the Funds showed that the extra 1s. per week could safely be allowed, and the Royal Commissioners accordingly decided to grant the addition.

In the early stages of the correspondence with the Royal Commissioners, the Council expressed the opinion that the rates of

re-marriage among widows in receipt of relief from the various Funds should be obtained before proceeding with the calculations. Although Colonel Young, the Secretary of the Royal Commissioners, did all in his power to push forward the preparation of this return, it arrived too late for use.

It contains the full particulars of the experience as to re-marriage and mortality of the largest Fund (the Russian War Fund), and is now in the possession of the Institute. It is hoped that these valuable records will be used by some Member of the Institute as the foundation of an interesting paper on a subject of great public importance, assuming, as there is every reason to hope, that the Commissioners would permit the publication of the information in question.

The following is the Report of the Council of the Institute referred to above :—

STAPLE INN HALL,

LONDON,

8 July 1901.

SIR,—In fulfilment of the trust imposed upon the President and Council of the Institute of Actuaries by your letter of the 21 February last, we have the honour to present our Report upon various Funds submitted for valuation.

The Schedules, as on 31 December 1900, of the numbers and ages of the recipients, the allowances to which they are entitled, and the assets to meet the liability for such payments, with which you furnished us, form the basis of our computations.

Before commencing the valuations, we carefully considered the conditions under which the Funds are administered, and we should have been glad to have had before us evidence as to the marriages and deaths among the recipients in the past, so that the previous experience of the Funds could have been made a basis for the estimate of future liabilities. You will remember, however, that though you took in hand at once an analysis of one of the larger Funds, yet, owing to the great extent of the records to be scheduled, and to the extreme pressure on your time, you were constrained to tell us on the 10 May that it would be impossible for you to supply us with the information soon enough for it to be made use of in the present valuations, seeing that they were required for the information of a Committee of both Houses then sitting. We immediately, therefore, proceeded with our calculations, nor do we think that the want is of moment, especially since our advice is not required as to the Transvaal War Fund, for the marriage rate is not an important factor in connection with the older Funds.

In the absence of specific information as to rates of re-marriage, we have assumed that all allowances paid to widows will be continued undiminished throughout their lives. This results in a slightly enhanced reserve being made; but the excess cannot be great, for nearly all the Funds now valued have been so long in

operation that the duration of widowhood of those in receipt of full pensions has reached that stage when re-marriage becomes rare.

The tables of mortality used by us have been :—

For all pensions, the tables deduced from the Experience of Government Annuitants (four years after purchase) and published in 1884, distinguishing males from females.

For allowanees to children and endowments, Dr. Farr's Healthy English Districts Life Tables, distinguishing males from females.

For allowanees to infirm persons, the English Life Table No. 3, distinguishing males from females.

Having in view the existing assets, and the fact that much further investing will not generally be required, we have adopted three per-cent as the rate of interest ; and this has been borne in mind when placing values upon the various securities.

Future expenses of management have been allowed for at their rate in 1900, the average ages of the recipients in the various Funds having been also kept in view.

There has of late been much deterioration in the value of first-class securities ; but, while we cannot advise that those in question should be taken as worth more than we have stated, we think it probable that a surplus will be derived from this source, if those to be sold are selected with prudence as occasion arises.

The results of the valuation of the various Funds are as follows :—*

VALUATION SUMMARY, 31 *December* 1900.

Name of Fund	Liabilities	Assets	Surplus	Deficiency
	£	£	£	£
Patriotic (Russian War, 1854-6) Fund	174,161	189,623	15,462	—
Patriotic (General) Fund	63,380	154,622	91,242	—
"Captain" Relief Fund	17,451	20,499	3,048	—
"Eurydice" Relief Fund	9,195	11,574	2,079	—
Zulu War Fund	17,621	21,101	3,480	—
"Atalanta" Relief Fund	6,460	7,600	1,140	—
Soldiers' Effects Fund	124,032	161,843	37,811	—
Ashantee War Fund	1,894	1,871	...	23†
Balaclava (Light Brigade) Relief Fund	1,611	2,236	625	—
"Victoria" Relief Fund	49,696	59,321	9,625	—
	£465,801	£630,290	£164,512	£23

* It has been thought sufficient to give here only a summary of these results.—ED. *J.I.A.*

† This deficiency will only arise in the event of full widows' allowances being in future granted to re-married women on the death of their husbands, as mentioned above.

The Royal Commissioners of the Patriotic Fund will be fully aware that rates of mortality can only be employed with confidence when applied to large bodies, for otherwise the discrepancy between forecast and fact is apt to be at times great. We, therefore, venture to recommend a general consolidation of the Funds, so that one set of assets would be the security for a variety of liabilities co-ordinated in proper proportion, and with due provision for the disposal of any surplus (or deficiency). It is practically impossible that Funds so small as are some of those under consideration can be worked out without serious departures from the averages upon which all valuations such as the present are based; and, moreover, great advantage would ensue, if a consolidation were effected, from the freedom then practicable for the selection of investments for sale.

We would further suggest that power should be obtained (if it is not held at present) for making investments in what are called "wasting" securities—loans, for instance, repayable in the form of annuities during periods of years, the annuities. Class A, of Indian Railways, &c.—for thus much selling of Stocks might be avoided.

In conclusion, we desire to express our acknowledgment of your courteous assistance while we have been pursuing our investigation.

We are, Sir,

Your obedient Servants,

C. D. HIGHAM, *President.*

ERNEST WOODS

F. SCHOOLING

Honorary

Secretaries.

*On behalf of the
Council of the Insti-
tute of Actuaries.*

To COLONEL J. S. YOUNG,

Secretary,

Royal Commission of the Patriotic Fund.

STATISTICS OF INDIAN GOVERNMENT ESTABLISHMENTS.

The following is the correspondence with the Census Office and the India Office, referred to by the President in his concluding remarks at the Sessional Meeting, held on 25 November 1901.

CENSUS OFFICE,

MILLBANK, LONDON, S.W.,

25 July 1901.

SIR,—I have been requested by the Under-Secretary of State for India to invite your Institute to consider whether the data collected from the Government Establishment Books are likely to furnish actuarial results of any value, and if so, on what lines the work of examining and collecting these data should be undertaken.

Should you be good enough to favour me with any expression of opinion such as is desired by the India Office, I shall regard it as a favour if a reply might be sent with as little delay as possible.

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In order to enable you the better to appreciate the point in question, I forward herewith a copy of a letter from the Government of India, dated 25 October, 1900.*

You will, no doubt, be good enough to return the enclosure with your reply.

I am, Sir,

Your obedient Servant,

REGINALD MACLEOD,
Registrar-General.

THE SECRETARY,
Institute of Actuaries,
Staple Inn, Holborn, W.C.

THE INSTITUTE OF ACTUARIES,
STAPLE INN HALL,
HOLBORN, W.C.,
30 July 1901.

DEAR SIR,—I beg to acknowledge receipt of your letter of the 25th instant, which I have had an opportunity of discussing with the President of this Institute, and think that there can be no doubt that a collection of data as therein indicated would be of great value to the Government of India and the public at large, as well as to those who are concerned in the management of assurance companies, but perhaps in due course it will be agreeable to you to favour me with a perusal of the tables referred to in the third paragraph of the printed letter of 25 October last.

The Institute of Actuaries would very gladly render any assistance in its power in making suggestions as to the arrangements necessary for the collection of data in the future, or for the use of particulars already obtained. If it should be thought desirable to put the India Office into communication with the Institute, the matter could probably be carried through with a minimum of delay.

As requested, I return the enclosures which accompanied your letter.

I am, Dear Sir,
&c., &c.,

ERNEST WOODS.

REGINALD MACLEOD, Esq.,
Registrar-General,
Census Office, Millbank, S.W.

CENSUS OFFICE,
MILLBANK, LONDON, S.W.,
1 August 1901.

SIR,—I have to acknowledge the receipt of your letter of the 30th ult., and, in reply, to inform you that I am sending a copy to the Secretary of State for India through the Local Government Board,

* It has not been thought necessary to reproduce this enclosure here.—
ED. J.L.A.

in anticipation that he will favour your President's suggestion that his department should communicate direct with the Institute.

I have the honour to be, Sir,

Your obedient Servant,

REGINALD MACLEOD,

Registrar-General.

E. WOODS, Esq.,

Honorary Secretary,

Institute of Actuaries,

Staple Inn Hall, Holborn, W.C.

LOCAL GOVERNMENT BOARD,

WHITEHALL, S.W.,

21 August 1901.

SIR,—I am directed by the Local Government Board to forward the enclosed copy of a letter which they have received from the Secretary of State for India relative to the tabulation of the Indian Census results.

I am, Sir,

Your obedient Servant,

H. C. MONRO,

Assistant Secretary.

THE SECRETARY,

The Institute of Actuaries.

[Copy.]

INDIA OFFICE,

WHITEHALL, LONDON, S.W.,

16 August 1901.

SIR,—In reply to your letter 96,385 C, dated 7 August 1901, regarding the collection of data by the Indian Census Commissioner for the preparation of a life table of the classes in India who are in the habit of insuring their lives, I am directed by the Secretary of State for India to say that his lordship will gladly receive, direct from the Institute of Actuaries, any suggestions for the assistance of the Government of India in the matter which the Society may be disposed to make. If verbal inquiries on any points are found necessary by the Institute, they should be addressed to the Secretary of the Revenue Department in this office.

I have the honour to be, Sir,

Your obedient Servant,

THE SECRETARY,

Local Government Board.

(Signed) A. GODLEY.

STAPLE INN HALL, LONDON,

12 November 1901.

SIR,—We beg leave to inform you that the letter of 16 August last ($\frac{104,702}{1901}$), addressed by the Secretary of State for India to the Secretary of the Local Government Board, of which a copy has been forwarded to the Council of the Institute of Actuaries, has received the consideration of the Council.

The investigation contemplated appears to the Council to be most desirable. By tracing the incidence of the mortality prevailing among Government servants in India during a period of years, an authoritative standard of the death rates among such classes would be obtained, which would form an important contribution to vital statistics. To the Government of India, the results of the

investigation would probably be of great value, inasmuch as they would show more clearly and accurately than any existing life table the mortality among their servants; while monetary tables based thereon would prove useful instruments for measuring the liability of Government and railway pension funds in the Dependency, as well as of the assurance companies in respect of their present and future engagements. For these reasons, the Council of the Institute is clearly of opinion that much public advantage would ensue were the records for the Government service to be examined, and mortality tables deduced from them for representative classes and races; for the Council presumes that such an inquiry would not be limited to merely one section of the public servants.

Should the Government of India accept these views, and resolve to undertake the investigation of the experience of the past as well as the tabulation of data for future use (which latter only appears to be at present contemplated), the Council recommends that the details should be recorded upon cards. We append for the consideration of the Executive a sketch for such a card with a draft of the instructions to be supplied to the officials entrusted with their preparation; and we enclose certain cards filled up as examples for some of the cases that may arise. The great convenience of cards for the classification and subdivision of facts is apparent, and wherever the card system has been introduced, either in assurance offices for actuarial valuations, or in the Colonies for Census purposes, we believe that it has given entire satisfaction. A card must, obviously, be written for *every individual entered on the registers* within the period of observation, even if not on the staff at its close; cards of different colours being used for the different races: probably all are males—if not, the sex should also be distinguished by colour: the cutting off of a corner of the card greatly assists sorting. If it be in any way possible, the after-history of those who have left the Service should be followed by recording the date of death, or the fact of continued existence at the conclusion of the period in question. This is a matter of considerable importance; for if deteriorated lives are withdrawn from the observations by resignation or dismissal, the mortality amongst the class of lives in question would almost certainly be under-estimated to an extent which might seriously impair the value of the investigation. Many other points might be mentioned, but the above will probably be sufficient to enable the question to be considered on general grounds.

The Council does not understand that more specific suggestions are sought, but if further technical information be needed, it will with pleasure render any service that may be in its power in furtherance of a work of so great public and private utility.

We are, Sir,

Your obedient Servants,

C. D. HIGHAM, <i>President.</i>	} <i>On behalf of the Council of the Institute of Actuaries.</i>
ERNEST WOODS } <i>Honorary</i>	
F. SCHOOLING } <i>Secretaries.</i>	

THE SECRETARY,
*Revenue Department,
India Office.*

COPY OF SUGGESTED CARD.

<i>No. on Register</i> <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <i>Office</i>..... </div> <div style="width: 45%;"> <i>Initials of Name</i>..... </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 10px;"> <div style="width: 45%;"> <i>Race</i>..... </div> <div style="width: 45%;"> <i>Class or Rank</i>..... </div> </div>		
DATE.		
DAY.	MONTH.	Year.
BIRTH		18.....
ENTRY		18.....
EXIT		1.....
MODE OF EXIT		
After-History of Withdrawals Date of Death If still living		

INDIA OFFICE, WHITEHALL,

LONDON, S.W., 18 *November* 1901.

SIR,—I am directed by the Secretary of State for India to acknowledge, with thanks, your letter of 12 November, conveying suggestions of the Council of the Institute of Actuaries on the proposed preparation of life tables from the Government Establishment Books in India.

A copy of your letter will be sent to the Government of India, with the specimen cards and the instructions for their use.

I am, Sir, your obedient Servant,

(Signed) T. W. HOLDERNESS,

Secretary,

Revenue and Statistics Department.

THE PRESIDENT,

Institute of Actuaries,

Staple Inn Hall, London.

LIST OF MEMBERS
OF
THE INSTITUTE OF ACTUARIES.

FOUNDED 1848.

INCORPORATED BY ROYAL CHARTER 29TH JULY, 1884.

(Corrected to 31 December, 1901.)

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1902.

THE INSTITUTE OF ACTUARIES,

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HARRY ETHELSTON NIGHTINGALE.

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*JOHN BELL TENNANT.

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*SAMUEL GEORGE WARNER.

ERNEST WOODS.

FRANK BERTRAND WYATT.

THOMAS EMLEY YOUNG, B.A.

* Not Members of the last Council.

TREASURER.

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ALEXANDER MACKAY.

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ALFRED G. WIGGINS.

THE INSTITUTE OF ACTUARIES.

LIST OF MEMBERS.

HONORARY MEMBER.

1894 LIEUT.-COL. W. H. OAKES, Stanley House, Granville Road, Sevenoaks.

FELLOWS.

*Those marked *** have passed the Examination for the Class of Fellow.*

Date of becoming a Fellow.		Date of becoming a Fellow.	
1876***	Ackland, Thomas Gans, F.S.S., Mem. Act. Soc. Amer., 3 & 4 Clement's-inn, W.C.	1885***	Andras, Henry Walsingham, F.S.S. (LIBRARIAN), Provident Life Office, 50 Regent-street, W.
1871***	Addiscott, Francis, Medical Sickness, Annuity & Life Assur. Soc., 33 Chancery-ln., W.C.	1885***	Ansell, Hubert, London Scottish-American Trust, 75 Lombard-street, E.C.
1892	Adlard, Alfred Barton, Law Life Assur. Soc., 187 Fleet-street, E.C.	1896***	Archer, Joseph Alfred, Ecclesiastical Commission, 10 Whitehall-place, S.W.
1901***	Adlard, Howard Tindale, A.K.C., The Equitable Life Assurance Society, Mansion-house-st., E.C.	1901***	Austin, Herbert Henry, Prudential Assurance Company, Holborn-bars, E.C.
1864***	Adler, Marcus Nathan, M.A., F.S.S., Alliance Assur. Co., Bartholomew-lane, E.C.	1850***	Bailey, Arthur Hutcheson, F.S.S. (PAST PRESIDENT, 1878-82), 26 Mount Ephraim-rd, Streatham, S.W.
1894***	Aldcroft, William Hancock, Refuge Assur. Co., Oxford-st., Manchester.	1896***	Baker, Henry James, (SUB-EDITOR OF JOURNAL), Metropolitan Life Assur. Soc., 13 Moorgate-street, E.C.
1889***	Allen, Arthur Gregory, 13 Fairfax-road, N.W.	1885***	Barnes, Joseph Howard, F.S.S., Pelican Life Insurance Co., 70 Lombard-street, E.C.
1897***	Allen, John Mayhew, Alliance Assur. Co., Bartholomew-lane, E.C.	1895***	Barrand, Arthur Rhys, Prudential Assurance Company, Holborn-bars, E.C.
1899***	Allin, Samuel John Henry Wallis, Mutual Insurance Co. of New York, 16, 17 & 18 Cornhill, E.C.	1890***	Bearman, Harry, Gresham Life Assur. Soc., St. Mildred's-house, Poultry, E.C.
1889***	Anderson, John, Hand-in-Hand Insurance Soc., 26 New Bridge-street, E.C.	1889***	Bell, Frederick, Imperial Life Insurance Co., 1 Old Broad-street, E.C.
1891***	Anderson, William Smith, Gresham Life Assurance Society, St. Mildred's-house, Poultry, E.C.		

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of
becoming
a Fellow.

- 1867***Berridge, George William,
Dunton-ldg., The Knoll, Becken-
ham, Kent.
- 1886***Berry, Berry Alfred, B.A.,
London Life Association Ltd.,
81 King William-street, E.C.
- 1895***Besant, Arthur Digby, B.A.,
Clerical, Medical & General Life
Assur. Soc., 15 St. James's-
square, S.W.
- 1879 Besso, Marco, F.S.S.,
Superior Trade Council, Rome.
- 1894***Blackadar, Alfred Kimball, M.A.,
Mem. Act. Soc. Amer.,
Government Insur. Department,
Ottawa, Canada.
- 1883***Blakey, James,
National Debt Office, Finsbury
Pavement House, E.C.
- 1897***Bradshaw, Thomas, Mem. Act. Soc.
Amer.,
The Imperial Life Assurance Co.
of Canada, Toronto, Canada.
- 1899***Brown, Edward Harold,
Prudential Assurance Company,
Holborn-bars, E.C.
- 1901***Brown, Hugh Wylie, F.F.A.,
Scottish Union & National Insur.
Company, 35 St. Andrew-square,
Edinburgh.
- 1875 Browne, Thomas G. C.,
Guardian Assurance Company,
11 Lombard-street, E.C.
- 1887 Browne, Willis,
India Office, S.W.
- 1901***Buchanan, James, M.A.,
Scottish Widows' Fund Life
Assurance Society, 9 St. Andrew-
square, Edinburgh.
- 1899***Bull, Ernest James,
Atlas Assur. Co., 92 Cheapside,
E.C.
- 1866***Bumsted, David Alexander,
General Reversionary and In-
vestment Co., Ltd., 26 Pall-mall,
S.W.
- 1894***Burn, Joseph,
Prudential Assurance Company,
Holborn-bars, E.C.

Date of
becoming
a Fellow.

- 1881***Burridge, Arthur Francis, Mem.
Act. Soc. Amer. (VICE-PRES.),
Equity and Law Life Ass. Soc.,
18 Lincoln's-inn-fields, W.C.
- 1887***Byers, Frederick Timothy Mason,
Clergy Mutual Assurance Soc.,
2 & 3 The Sanctuary, West-
minster, S.W.
- 1888***Calderon, Henry Philip,
51 Maryland-road, Bowes Park,
N.
- 1871***Carment, David, F.F.A., Mem. Act.
Soc. Amer.,
Australian Mutual Provident
Society, Sydney, Australia.
- 1889***Chatham, James, F.F.A., F.S.S.,
Scottish Life Assurance Co.,
19 St. Andrew-sq., Edinburgh.
- 1875 Cherriman, J. B., Prof., M.A.,
c/o The Bank of Montreal,
Abchurch-lane, E.C.
- 1883 Chisholm, James, F.F.A., Mem. Act.
Soc. Amer. (VICE-PRESIDENT),
Imperial Life Insurance Co.,
1 Old Broad-street, E.C.
- 1895***Clarke, Arthur Harold,
Clerical, Medical and General
Life Assurance Society, 15 St.
James's-square, S.W.
- 1863 Clirehugh, William Palin, F.S.S.,
London and Lancashire Life
Assurance Company, 66 & 67
Cornhill, E.C.
- 1879 Cockburn, Henry, F.F.A., Mem.
Act. Soc. Amer. (TREASURER),
North British and Mercantile
Insurance Co., 61 Threadneedle-
street, E.C.
- 1886 Cockburn, Henry Robertson,
F.F.A.,
Scottish Provident Institution,
6 St. Andrew-sq., Edinburgh.
- 1898***Cockman, Arthur Charles Road-
night,
Liverpool and London and Globe
Insurance Co., 1 Dale-street,
Liverpool.
- 1884***Colenso, Francis Ernest, M.A.,
Eagle Insurance Company, 79
Pall-mall, S.W.

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of becoming a Fellow.		Date of becoming a Fellow.	
1861***	Coles, John, J.P., F.S.S., 39 Throgmorton-street, E.C.	Under the Charter.	Docker, Edward, M.A., Dudley-house, Spring-grove, Isleworth.
1882***	Colquhoun, Ernest, <i>Legal and General Life Assur. Society</i> , 10 Fleet-street, E.C.	1887	Douglas, Gordon, F.F.A., <i>Life Association of Scotland</i> , 82 Princes-street, Edinburgh.
1875***	Cooke, Thomas Homans, Glendower, Torre Vale, Torquay.	1875***	Duncan, James Heron, <i>Royal Exchange Assurance Corp.</i> , <i>Royal Exchange</i> , E.C.
1889***	Cooper, Walter George, <i>Norwich Union Life Insurance Society</i> , Norwich.	1874***	Duncan, John, <i>Clergy Pensions Institution and Ecclesiastical Insurance Office</i> , 11 Norfolk-street, Strand, W.C.
1878***	Crisford, George Stephen, <i>Rock Life Assurance Company</i> , 15 New Bridge-street, E.C.	1901***	Dunn, Spencer Græme, <i>University Life Assurance Soc.</i> , 25 Pall Mall, S.W.
1889***	Cross, Robert, <i>Atlas Assurance Company</i> , 92 Cheapside, E.C.	1869	Dymond, Joseph John, <i>Friends' Provident Institution</i> , Bradford, Yorkshire.
1864	Curtis, Frank Allan, 3 Ennismore-gardens, Salisbury-road, Dover.	1872	Eccles, Yvon Richard, <i>Scottish Amicable Life Assurance Society</i> , 1 Threadneedle-st., E.C.
Under the Charter.	Davies, Griffith, 11 Freeland-road, Ealing, W.	1897***	Elder, Kenneth William, <i>Atlas Assurance Company</i> , 92 Cheapside, E.C.
1898***	Dawson, Charles Pearl, <i>Imperial Life Insurance Co.</i> , 1 Old Broad-street, E.C.	1901***	Elderton, William Palin, <i>Guardian Assurance Company</i> , 11 Lombard-street, E.C.
1855***	Day, Archibald (PAST PRESIDENT, 1886-88), Clifton-lodge, St. John's-park-road, Blackheath, S.E.	1898***	Elliott, Charles Alfred, <i>Australian Mutual Provident Society</i> , Sydney, Australia.
1885***	Day, Stanley, <i>Marine and General Mutual Life Assurance Society</i> , 14 Leaden-hall-street, E.C.	1889***	Faulks, Joseph Ernest, B.A., F.S.S., <i>Law Life Assurance Society</i> , 187 Fleet-street, E.C.
1897***	Day, William Reginald, <i>The Standard Life Association, Ltd.</i> , 28 Elizabeth-street, Sydney, Australia.	1897***	Fellows, Rowland Hill, F.S.S., <i>British Empire Mutual Life Assurance Company</i> , 4 & 5 King William-street, E.C.
1869	Deuchar, David, F.F.A., F.R.S.E., Mem. Act. Soc. Amer., <i>Caledonian Insurance Company</i> , 19 George-street, Edinburgh.	Under the Charter.	Fisher, Richard Charles, 2 Walsingham-rd., W. Brighton.
1883	Deuchar, John Jas. Walker, F.F.A., <i>Norwich Union Life Insurance Society</i> , Norwich.	1892***	Foot, Herbert, B.A., <i>Northern Assurance Company</i> , 1 Moorgate-street, E.C.
1882	Dewey, Thomas Charles, <i>Prudential Assurance Company</i> , Holborn-bars, E.C.	1884	Frankland, Frederick William, F.S.S., Mem. Act. Soc. Amer., <i>New York Life Insurance Co.</i> , 346 & 348 Broadway, New York.
1886***	Dickinson, Arthur Lowes, M.A., F.C.A., 54 Wall-street, New York, U.S.A.	1900***	Fraser, Alexander, Jr., F.F.A., <i>Scottish Life Assur. Company</i> , 19 St. Andrew-sq., Edinburgh.

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of becoming a Fellow.		Date of becoming a Fellow.	
1897***	Fraser, Duncan Cumming, M.A., <i>Royal Insurance Co., Liverpool.</i>	1896***	Henderson, Robert, B.A., <i>Equitable Life Assurance Soc. of the United States, 120 Broadway, New York.</i>
1895***	Fulford, Frederick Wesley, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1864	Hendriks, Augustus, F.S.S., Mem. Act. Soc. Amer. (PAST PRESIDENT, 1892-94), <i>Liverpool and London and Globe Insur. Co., 7 Cornhill, E.C.</i>
1901***	Gibson, J. Paul S. R., <i>15 Inglewood-road, West Hampstead, N.W.</i>	Under the Charter.	Hendriks, Frederick, F.S.S., <i>7 Vicarage-gate, Kensington, W.</i>
1887	Gillison, John Broth, F.F.A., <i>National Mutual Life Association of Australasia, Corner of Collins and Queen-streets, Melbourne, Australia.</i>	1883	Hewat, Archibald, F.F.A., F.S.S., <i>Edinburgh Life Assurance Co., 22 George-street, Edinburgh.</i>
1878	Gordon, Charles, F.F.A., <i>South African Mutual Life Assurance Society, Cape Town.</i>	1874***	Higham, Charles Daniel, Mem. Act. Soc. Amer. (PRESIDENT), <i>London Life Association Ltd., 81 King William-street, E.C.</i>
1901***	Gordon-Smith, Randolph, F.F.A., <i>Scottish Amicable Life Assur. Soc., 35 St. Vincent-pl., Glasgow.</i>	1898***	Hodgson, William Horsford, <i>Law Life Assurance Society, 187 Fleet-street, E.C.</i>
1882***	Graham, James, F.F.A., <i>Australian Widows' Fund Life Assurance Society, Collins-street-west, Melbourne, Australia.</i>	1899***	Holliday, John, M.A., F.S.S., <i>La Equitativa del Plata Insur. Co., calle Piedad, 556, Buenos Ayres.</i>
1886	Gunn, Niel Ballingal, F.F.A., <i>Scottish Amicable Life Assur. Soc., 35 St. Vincent-place, Glasgow.</i>	1888***	Hopkins, William Raynes, <i>London & Lancashire Life Assur. Co., 66 & 67 Cornhill, E.C.</i>
1864	Harben, Sir Henry, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1890***	Hovil, Lewis Frederick, <i>National Provident Institution, 48 Gracechurch-street, E.C.</i>
1880***	Hardy, George Francis (VICE-PRESIDENT), <i>Universal Life Assurance Soc. 1 King William-street, E.C.</i>	1871***	Hughes, William, Mem. Act. Soc. Amer., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1870***	Hardy, Ralph Price, <i>61 Addison-road, W.</i>	1894***	Hutcheson, William Anderson, F.F.A., <i>Mutual Life Insurance Company of New York, Nassau-street, New York, U.S.A.</i>
1893***	Harris, Arnold Stoughton, M.A., <i>Clerical, Medical & General Life Assur. Soc., 40 Prince of Wales-road, Norwich.</i>	1893***	Hutton, William, F.F.A., <i>Scottish Amicable Life Assur. Soc., 1 Threadneedle-street, E.C.</i>
1892***	Hart, James Robert, <i>British Empire Mut. Life Assur. Co., 4 & 5 King William-st., E.C.</i>	1869***	Justican, Edwin, F.S.S., <i>Gresham Life Assurance Society, St. Mildred's-house, Poultry, E.C.</i>
1879	Harvey, Chas. J., <i>The Colonial Life Insce. Co. of America, 43 Montgomery-street, Jersey City, N.J., U.S.A.</i>		
1888***	Hemming, Arthur George, F.S.S., <i>London Assurance Corporation, 7 Royal Exchange, E.C.</i>		

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

- | Date of
becoming
a Fellow. | Date of
becoming
a Fellow. |
|---|---|
| 1897*** Kentish, Owen,
<i>Economic Life Assurance Soc.,
6 New Bridge-street, E.C.</i> | 1900*** Macnaghten, Steuart Edye, A.C.A.,
<i>54 Manchester-street, W.</i> |
| 1874*** King, George, F.F.A., Mem. Act.
Society Amer. (EDITOR OF
JOURNAL),
<i>12 Sunderland-terrace, Westbourne-
gardens, London, W.</i> | 1901*** Macphail, Donald, F.F.A.,
<i>Yorkshire Insurance Company,
York.</i> |
| 1887*** Kyd, Thomas, F.F.A.,
<i>Northern Assurance Company,
1 Union-terrace, Aberdeen.</i> | 1870*** Manly, Henry William, Mem. Act.
Soc. Amer. (EX-PRESIDENT),
<i>Equitable Life Assurance Soc.,
Mansion-house-street, E.C.</i> |
| 1876*** Laing, Francis, F.F.A.,
<i>Northern Assurance Company,
1 Moorgate-street, E.C.</i> | 1890*** Marks, Geoffrey (LIBRARIAN),
<i>National Mutual Life Assur. Soc.,
39 King-street, Cheapside, E.C.</i> |
| 1882 Lancaster, William John,
<i>South Lynn, Putney-hill, S.W.</i> | 1900*** Marr, Vyvyan, F.F.A.,
<i>Edinburgh Life Assurance Co.,
22 George-street, Edinburgh.</i> |
| 1894*** Loughton, Alexander Millar, F.F.A.,
<i>National Mutual Life Assoc. of
Australasia, Limited, Corner of
Collins and Queen-streets, Mel-
bourne, Australia.</i> | 1897*** May, George Ernest,
<i>Prudential Assurance Company,
Holborn-bars, E.C.</i> |
| 1887*** Lemon, William Kent, Barrister-
at-Law,
<i>5 Pump-court, E.C.</i> | 1875 McCabe, William, LL.B., F.S.S.,
Mem. Act. Soc. Amer.,
<i>North American Life Assur. Co.,
North American Life Building,
112-118 King-st.-west, Toronto,
Canada.</i> |
| 1896*** Levine, Abraham, M.A. (SUB-
EDITOR OF JOURNAL),
<i>National Mutual Life Assur.
Soc., 39 King-st., Cheapside, E.C.</i> | 1874 McClintock, Emory, Mem. Act.
Soc. Amer.,
<i>Mutual Life Insurance Company
of New York, New York.</i> |
| 1896*** Lewis, John Norman, F.F.A.,
<i>London Assurance Corporation,
7 Royal Exchange, E.C.</i> | 1894*** McDonald, John,
<i>Prudential Assurance Company,
Holborn-bars, E.C.</i> |
| 1892*** Lidstone, George James,
<i>Alliance Assur. Co., Bartholo-
mew-lane, E.C.</i> | 1864 McGedy, Frank,
<i>14 Fitz-George-avenue, Ken-
sington West.</i> |
| 1901*** Little, James Fulton,
<i>Mutual Life Association of Aus-
tralasia, Sydney, Australia.</i> | 1883*** McGowan, James, B.A.,
<i>The Treasury, Cape Town.</i> |
| 1899 Low, George Macritchie, F.F.A.,
<i>Scottish Equitable Life Assur.
Society, 28 St. Andrew-square,
Edinburgh.</i> | 1851*** Meikle, James, F.F.A., Mem. Act.
Soc. Amer.,
<i>Scottish Provident Institution,
6 St. Andrew-sq., Edinburgh.</i> |
| 1899*** Lutt, Harold Edward William,
<i>Mutual Life Association of Aus-
tralasia, 5, Lothbury, Bank, E.C.</i> | 1897*** Miller, Neville,
<i>London Assurance Corporation,
7 Royal Exchange, E.C.</i> |
| 1898*** Macaulay, Thomas Bassett, Mem.
Act. Soc. Amer.,
<i>Sun Life Assurance Co. of
Canada, Montreal, Canada.</i> | 1893*** Milner, John William,
<i>North British & Mercantile Insur.
Co., 61 Threadneedle-street, E.C.</i> |
| 1885 Mackenzie, Alexander George,
F.F.A.,
<i>47, York-terrace, Regent's-park,
N.W.</i> | 1892*** Milton, Henry, M.A.,
<i>37 Threadneedle-street, E.C.</i> |
| | 1899*** Moir, Henry, F.F.A.,
<i>Provident Savings Life Assur.
Soc., 346, Broadway, New York,
U.S.A.</i> |

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of becoming a Fellow.		Date of becoming a Fellow.	
1890***	Molyneux, Arthur Ernest, <i>Provident Clerks' Mutual Life Assurance Association, 27 & 29 Moorgate-street, E.C.</i>	1891***	Pulley, William Pritchard, <i>Norwich Union Life Insur. Soc., 71 & 72 King William-st., E.C.</i>
1901***	Moorhouse, Alfred, <i>Friends' Provident Institution, Bradford.</i>	1899***	Raisin, Arthur Herbert, <i>Pelican Life Ins. Co., 70 Lombard-street, E.C.</i>
1897***	Moors, Elphinstone MacMahon, M.A., <i>University of Sydney, Australia.</i>	1897***	Rees, Martin, <i>Law Reversionary Interest Soc., Ltd., 24 Lincoln's-inn-fields, W.C.</i>
1896***	Moran, Joseph Flack, <i>Marine & General Mutual Life Assurance Society, 14 Leadenhall-street, E.C.</i>	1901***	Reeve, Charles Ernest, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>
1900***	Morgan, Benjamin Charles, M.A., <i>Commercial Union Assur. Co., 24, 25 & 26 Cornhill, E.C.</i>	1898***	Robinson, George Frederick, <i>Legal and General Life Assur. Society, 10 Fleet-street, E.C.</i>
1895***	Muter, Percy, <i>New Zealand Government Life Insurance Department, Wellington, New Zealand.</i>	1888***	Rusher, Edward Arthur, F.S.S., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1888***	Nash, Willie Oscar, <i>Law Reversionary Interest Soc., Ltd., 24 Lincoln's-inn-fields, W.C.</i>	1882***	Ryan, Gerald Hemington, Mem. Act. Soc. Amer., <i>British Empire Mutual Life Assurance Co., 4 & 5 King William-street, E.C.</i>
1883	Neison, Francis G. P., F.S.S., <i>19 Abingdon-st., Westminster, S.W.</i>	1898***	Salmon, Richard George, F.S.S., <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>
1888***	Newman, Philip Lewin, B.A., <i>Yorkshire Insurance Co., York.</i>	1883	Saunders, Harris Charter Lindon, F.R.A.S., <i>28 Holland-road, Kensington, W.</i>
1865	Newton, Algernon, M.A., <i>c/o London & Westminster Bank, 94 & 96 High-st., Kensington, W.</i>	1886***	Schooling, Frederick (HON. SEC.), <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1887***	Nightingale, Harry Ethelsan, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>	1901***	Searle, George Morley, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>
1901***	Norton, William Ernest, <i>National Provident Institution, 48 Gracechurch-street, E.C.</i>	1901***	Sharman, William Charles, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1899***	Parker, Robert Peter, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>	1896***	Sim, William Abernethy, F.F.A., <i>Scottish Union and National Insurance Co., 35 St. Andrew-square, Edinburgh.</i>
1864	Pearson, Arthur, <i>Betchworth-house, The Bank, Highgate, N.</i>	1875***	Smither, Arthur, <i>National Provident Institution, 48 Gracechurch-street, E.C.</i>
1891***	Phelps, William Peyton, M.A., <i>Equity and Law Life Assur. Soc., 18 Lincoln's-inn-fields, W.C.</i>	1881***	Somerville, William Finlay, <i>Liverpool and London and Globe Insurance Co., 7 Cornhill, E.C.</i>
Under the Charter.	Priestley, John George, <i>44 St. German's-road., Forest-hill, S.E.</i>		

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of becoming a Fellow.		Date of becoming a Fellow.	
1877***	Sorley, James, F.F.A., C.A., F.R.S.E., <i>Pelican Life Insurance Company,</i> <i>70 Lombard-street, E.C.</i>	1887	Teece, Richard, F.F.A., F.S.S., Mem. Act. Soc. Amer., <i>Australian Mutual Provident Society, Sydney, Australia.</i>
1898***	Spencer, John, <i>English and Scottish Law Life Assurance Assoc., 12 Waterloo-place, S.W.</i>	1872	Templeton, Col. John M., C.M.G., <i>National Mutual Life Association of Australasia, Melbourne, Australia.</i>
1894***	Spragne, Alfred Ernest, B.Sc., M.A., F.F.A., <i>Edinburgh Life Assurance Co.,</i> <i>22 George-street, Edinburgh.</i>	1886	Tennant, John Bell, <i>Friends' Provident Institution,</i> <i>Bradford, Yorkshire.</i>
1857	Sprague, Thomas Bond, M.A., LL.D., F.F.A., F.S.S., F.R.S.E. (PAST PRESIDENT, 1882-86), <i>29 Buckingham-terrace, Edinburgh.</i>	1864***	Terry, James, <i>Herulee, Lyme Regis, Dorset.</i>
1896***	Stahlschmidt, Louis, <i>Imperial Life Insurance Co.,</i> <i>1 Old Broad-street, E.C.</i>	1889***	Thiselton, Herbert Cecil, F.F.A., Mem. Act. Soc. Amer., <i>Hand-in-Hand Insurance Soc.,</i> <i>26 New Bridge-street, E.C.</i>
Under the Charter.	Stevens, Charles, <i>Aberdeen Ho., Preston, Brighton.</i>	1901***	Thodey, Robert, <i>Australian Mutual Provident Society, Sydney, Australia.</i>
1888	Stewart, John, F.F.A., <i>City of Glasgow Life Assur. Co.,</i> <i>30 Renfield-street, Glasgow.</i>	1893***	Thomas, Ernest Charles, <i>Gresham Life Assurance Society,</i> <i>St. Mildred's-house, Poultry, E.C.</i>
1898	Stirling, Robert, F.F.A., <i>Law Union & Crown Insurance Co., 126 Chancery-lane, W.C.</i>	1899***	Thomas, Robert Arthur Caradoc, <i>British Empire Mutual Life Assur. Co., 4 & 5 King William-street, E.C.</i>
1868***	Strachan, Thomas Young, <i>Jethart, High View-road, Sidcup.</i>	1895***	Thomson, Herbert Archer, B.A., <i>Parkwood House, Whetstone, N.</i>
1892***	Straker, Edward Robert, <i>British Empire Mutual Life Assurance Co., 4 & 5 King William-street, E.C.</i>	1880	Thomson, Robert, <i>Colonial Mutual Life Assurance Society, Collins - street - west, Melbourne, Australia.</i>
1878***	Straker, Frank Arthur, <i>Legal and General Life Assur. Society, 10 Fleet-street, E.C.</i>	1876	Thomson, Spencer Campbell, B.A., F.F.A., <i>Standard Life Assurance Co.,</i> <i>3 George-street, Edinburgh.</i>
1884***	Stuart, John Moody, F.F.A., <i>The Leeds Permanent Building Society, Victoria-buildings, Park-lane, Leeds.</i>	1893***	Thorne, Alfred Charles, <i>Equity & Law Life Assur. Soc.,</i> <i>18 Lincoln's-inn-fields, W.C.</i>
1900***	Sutherland, John, M.A., <i>Temperance & General Mutual Life Assur. Soc., Swanston-street, Melbourne, Australia.</i>	1891***	Tilt, Robert Ruthven, <i>General Reversionary & Investment Co., Ltd., 26 Pall-mall, S.W.</i>
1889***	Tarn, Arthur Wyndham, <i>Westminster and General Life Assurance Association, 28 King-street, Covent-garden, W.C.</i>	1881***	Todd, George, M.A., <i>Economic Life Assurance Society,</i> <i>6 New Bridge-street, E.C.</i>
		1894***	Todhunter, Ralph, M.A., <i>University Life Assur. Soc.,</i> <i>25 Pall-mall, S.W.</i>
		1899***	Trouncer, Harold Moltke, B.A., <i>London Life Association Ltd.,</i> <i>81 King William-street, E.C.</i>

FELLOWS.

Those marked *** have passed the Examination for the Class of Fellow.

Date of becoming a Fellow.		Date of becoming a Fellow.	
1878	Turnbull, Andrew Hugh, F.F.A., F.R.S.E., <i>Scottish Widows' Fund Life Assur. Soc., 9 St. Andrew-square, Edinburgh.</i>	1888***	Wilson, Robert, Jun., <i>General Assurance Company, 103 Cannon-street, E.C.</i>
Under the Charter.	Tyndall, William Henry, F.S.S., F.R.Met.S., <i>Morlands, Oxford-road, Redhill, Surrey.</i>	Under the Charter.	Winsor, Thomas Boorman, <i>81 Shooter's-hill-road, Blackheath, S.E.</i>
1889	Wallace, Thomas, F.F.A., <i>North British & Mercantile Insurance Co., Edinburgh.</i>	1899***	Winter, Arthur Thomas, <i>The British Empire Mutual Life Assurance Company, 10 and 11 Dalhousie-square, Calcutta.</i>
1888***	Warner, Samuel George, <i>Law Union & Crown Insur. Co., 126 Chancery-lane, W.C.</i>	1897***	Wintle, Lancelot Andrewes, <i>Economic Life Assurance Soc., 6 New Bridge-street, E.C.</i>
1893***	Watson, Alfred William, <i>Manchester Unity Friendly Soc., Nottingham.</i>	1884***	Woods, Ernest, Mem. Act. Soc. Amer. (HON. SECRETARY), <i>Westminster and General Life Assur. Assoc., 28 King-street, Covent-garden, W.C.</i>
1895***	Watson, James Douglas, <i>English & Scottish Law Life Assr. Assoc., 12 Waterloo-place, S.W.</i>	1875***	Wyatt, Frank Bertrand, Mem. Act. Soc. Amer. (VICE-PRESIDENT), <i>Clergy Mutual Assurance Soc., 2 & 3 The Sanctuary, S.W.</i>
1880***	Whittall, Wm. Joseph Hutchings, Mem. Act. Soc. Amer., <i>Clerical, Medical & General Life Assur. Soc., 15 St. James's-sq., S.W.</i>	1874	Young, Thomas Emley, B.A., F.R.A.S. (PAST-PRESIDENT, 1896-8), Mem. Act. Soc. Amer., <i>Commercial Union Assur. Co., Ltd., 24, 25 & 26 Cornhill, E.C.</i>
1864	Wilson, Robert, <i>44 Talfourd-rd., Camberwell, S.E.</i>		

ASSOCIATES.

Those marked * have passed the first of the three parts of the Examination for the Class of Fellow. Those marked ** have passed two of the three parts of the Examination for the Class of Fellow; those marked **a, or **b, have also passed either Section A or Section B of Part III of the Examination.

Date of becoming an Associate.	Date of becoming an Associate.
1900** Adams, Cecil Francis, <i>Ocean Accident and Guarantee Corporation, Ltd., Wellington, New Zealand.</i>	1889 Bremner, Thomas William, F.F.A., <i>Mutual Life Insurance Co. of New York, Sydney, Australia.</i>
1869** Adey, Theodore Henry, <i>Scottish Provident Institution, 17 King William-street, E.C.</i>	1878** Bridgman, Arthur Henry, <i>Equity & Law Life Assur. Soc., 18 Lincoln's-inn-fields, W.C.</i>
1899** Adlard, Stanley, A.K.C., <i>London Life Association Ltd., 81 King William-street, E.C.</i>	1896 Brown, George Andrew, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>
1899**b Anderson, Thomas Frederic, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>	1899** Brown, Harold, <i>Scottish Union and National Insurance Co., 3 King William-street, E.C.</i>
1899** Ansell, George Frederic, <i>National Debt Office, Finsbury Pavement House, E.C.</i>	1900** Brown, Henry, B.A., <i>Hand-in-Hand Insurance Soc., 26 New Bridge-street, E.C.</i>
1898**b Appleton, Frederick, <i>London Life Association Ltd., 81 King William-street, E.C.</i>	1901** Buckler, William Peach, B.A., <i>2 Collingham-gardens, South Kensington, W.</i>
1883** Ashley, John Geo., M.A., <i>War Office, S.W.</i>	1886 Buckley, Thomas John Wesley, <i>9 St. Andrew-street, Holborn-circus, E.C.</i>
1901** Ashton, William Richard, <i>Hand-in-Hand Insurance Soc., 26 New Bridge-street, E.C.</i>	1882 Burke, David, F.S.S., <i>Royal Victoria Life Insur. Co., Montreal, Canada.</i>
1881** Ayling, Charles Stephen, <i>Commercial Union Assur. Co., 20 New Bridge-street, E.C.</i>	1900** Burnley, Isaac, <i>Australian Mutual Prov. Society, Sydney, Australia.</i>
1885 Barton, Arthur, <i>United Kent Insurance Institution, Maidstone.</i>	1895**a Butterfield, William Thos., A.C.A., <i>29 Pearl-buildings, 19 Market-street, Bradford.</i>
1894**a Barton, Robert Whitchurch, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>	1876* Carter, Eric Mackay, <i>33 Waterloo-street, Birmingham.</i>
1901** Benjamin, Stanley O., <i>Australian Mutual Provident Society, Melbourne.</i>	1899** Catchlove, Chas. Hamilton Leyland, <i>Australian Mutual Provident Society, Adelaide, S. Australia.</i>
1881 Birks, Edmund Alfred, <i>Yorkshire Insurance Co., York.</i>	1900** Chandler, Thomas Richard, <i>London Assurance Corporation, 7 Royal Exchange, E.C.</i>
1873** Block, Robert John, <i>Essex-villa, Chelsham-road, Clapham, S.W.</i>	1898** Coates, Thomas Linnaeus, <i>North British and Mercantile Insurance Co., 61 Threadneedle-street, E.C.</i>
1898 Blount, Edward Thos. J., F.F.A., F.S.S., <i>Standard Life Assurance Co., Shanghai, China.</i>	1871 Cook, Arthur James, M.J.I., <i>Victoria Mutual Assur. Society, Farringdon-street, E.C.</i>
1873** Boon, Gerald Inglis, <i>Law Accident Insurance Society, 215 Strand, London.</i>	1899**b Cook, William Playfair, <i>Guardian Assurance Company, 11 Lombard-street, E.C.</i>

ASSOCIATES.

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Date of becoming an Associate.		Date of becoming an Associate.	
1878	Cooke, George, <i>Commercial Union Assur. Co., Ltd., 24, 25 & 26 Cornhill, E.C.</i>	1901	Donald, Alexander Graham, M.A., F.F.A., <i>Scottish Provident Institution, 6 St. Andrew-square, Edinburgh.</i>
1897**	Coop, Charles Rowland, <i>United Kingdom Temperance and General Provident Institution, 5 Bennett's-hill, Birmingham.</i>	1881	Donaldson, John, <i>Australian Widows' Fund Life Assurance Society, Collins-street-west, Melbourne, Australia.</i>
1891**	Coote, Ernest Charles, <i>Alliance Assurance Company, Bartholomew-lane, E.C.</i>	1899**	Dougharty, Harold, F.S.S., <i>London & Lancashire Life Assur. Company, 66 & 67 Cornhill, E.C.</i>
1900**	Corbett, Edwin Somerville, <i>The Standard Life Assoc., Ltd., 28 Elizabeth-street, Sydney, Australia.</i>	1881	Dovey, William Roadly, F.F.A., Mem. Act. Soc. Amer., <i>c/o A. M. Dovey, Mercantile Bank of India, 40, Threadneedle-st., E.C.</i>
1897**a	Coutts, Charles Ronald Vawdrey, <i>Hand-in-Hand Insur. Society, 26 New Bridge-street, E.C.</i>	1870*	Dowson, John, <i>Royal Insur. Company, Liverpool.</i>
1871	Contts, Edwin Arthur, <i>North British and Mercantile Insurance Company, Victoria-street, Nottingham.</i>	1898**	Doyle, Arthur James, <i>54 Bourke-st., Sydney, Australia.</i>
1900**	Covington, Oliver Henry, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1901**	Earle, Arthur Percival, <i>North American Life Assur. Co., North American Life Building, 112-118 King-st.-west, Toronto, Canada.</i>
1884	Craig, Robert Alexander, <i>Abstainers' and General Assur. Co., City Buildings, Birmingham.</i>	1868*	Eaton, Henry William, <i>Liverpool and London and Globe Insurance Company, William-street, New York, U.S.A.</i>
1901**	Cross, Howard Turner, <i>Economic Life Assurance Soc., 6 New Bridge-street, E.C.</i>	1872**	Evans, William, F.F.A., F.R.S.E., <i>38 Morningside-park, Edinburgh.</i>
1901**	Culley, Alfred Benjamin, <i>Star Life Assurance Society, 32 Moorgate-street, E.C.</i>	1896**	Featherstonehaugh, William Irwin, <i>Commercial Union Assurance Co., 24, 25 & 26 Cornhill, E.C.</i>
1901**	Curjel, H. W., M.A., <i>Royal Insurance Co., Liverpool.</i>	1897**	Findlay, Alexander Wynaud, LL.B., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1900**	Curtis, William Allen, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>	1901**	FitzGerald, William George, <i>London & Lancashire Life Assurance Co., 164 St. James'-st., Montreal.</i>
1901	Denham, Walter, F.F.A., <i>City of Glasgow Life Assurance Co., 30 Renfield-street, Glasgow.</i>	1890	Fox, Charles Edward, F.F.A., <i>Standard Life Assurance Co., 83 King William-street, E.C.</i>
1901**	Diamond, George Frederick, <i>City Mutual Life Assurance Society, Hunter-street, Sydney, Australia.</i>	1886	Fox, Morris, Mem. Act. Soc. Amer., <i>New Zealand Government Life Insur. Dept., Wellington, New Zealand.</i>
1900**	Diver, Oswald Francis, M.A., <i>Clerical, Medical & General Life Assur. Soc., 15 St. James'-sq., S.W.</i>	1894**	Fraser, Thomas John, <i>Australian Alliance Assurance Company, Melbourne, Australia.</i>
1855	Dix, James, <i>Hurstdale, Wood-la., Highgate, N.</i>		

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Date of becoming an Associate.		Date of becoming an Associate.	
1901	Gaff, William Robertson, C.A., F.F.A., 3 Crown-court, Old Broad-st., E.C.	1893**	Hall, John Francis Edmund, Eagle Insurance Company, 79 Pall-mall, S.W.
1873**	Gage, Uriah Woodard, Universal Life Assur. Society, 1 King William-street, E.C.	1869	Hann, Robert George, Mem. Act. Soc. Amer., The Equitable Life Assur. Soc. of the United States, 120 Broadway, New York.
1897**b	Galer, Frederic Bertram, B.A., Rock Life Assurance Company, 15 New Bridge-street, E.C.	1894**	Harcastle, Edwd. Edgington, M.A., Union Central Life Office, Cincinnati, Ohio, U.S.A.
1895**	Galwey, Charles Edmund, New Zealand Government Life Insur. Dept., Wellington, New Zealand.	1900**	Harding, Harry Burnard, Hand-in-Hand Insurance Soc., 26 New Bridge-street, E.C.
1893**	Gardiner, Robert Edward, Sun Life Assurance Society, 63 Threadneedle-street, E.C.	1896**a	Harris, Frederick Joseph, Australian Mutual Provident Society, Sydney, Australia.
1885**	Gayford, Herbert Stannard, Northern Assurance Co., 81 Colmore-row, Birmingham.	1897**	Hayeraft, William Melhuish, Prudential Assurance Company, Holborn-bars, E.C.
1899**b	Gibb, James Burnett, F.F.A., Penn Mutual Life Insce. Co. of Philadelphia, 923 Chestnut-st., Philadelphia, U.S.A.	1897**	Hazell, James Stanley, National Provident Institution, 48 Gracechurch-street, E.C.
1897**a	Gillies, George, Union Ins. Soc., 51 Cornhill, E.C.	1895**	Heness, Leonard Thomas, Prudential Assurance Company, Holborn-bars, E.C.
1871**	Glennie, William Gordon, Scottish Union & National Insur. Co., 3 King William-street, E.C.	1878	Henry, Alfred, F.C.A., Throgmorton-house, Copthall-avenue, E.C.
1895**a	Glover, Henry Walter, Pullinger House, Beaconsfield, Cape Colony.	1900**	Hicks, Arthur Joseph, Reversionary & General Securities Company, Ltd., Craven House, Northumberland-avenue, W.C.
1897**	Goggs, Frank Sidney, Scottish Metropolitan Life Assur. Co., 25 St. Andrew-sq., Edinburgh.	1884	Higham, William Samuel, Equitable Life Assurance Soc., Mansion-house-street, E.C.
1882	Goldman, Leopold, North American Life Assurance Co., North American Life Building, 112-118 King-street-west, Toronto, Canada.	1894**	Hollingworth, Albert Chas., Australian Mutual Provident Society, Sydney, Australia.
1897**	Goodwyn, John, Jun., 41 St. Giles-street, Norwich.	1883	Holt, Edward Hallett, Law Life Assurance Society, 187 Fleet-street, E.C.
1888	Gray, John, Scottish Widows' Fund Life Assur. Society, 28 Baldwin-st., Bristol.	1894**	Home, Noel Charles Minchin, LL.B., F.S.S., 5 King's Bench-walk, Temple, E.C.
1898**	Green, George, B.A., Union Insurance Society, 81 Cornhill, E.C.	1898**	Howell, Chas. Edward, B.A., LL.D., Standard Life Assurance Comp., 66 Upper Sackville-st., Dublin.
1868*	Greig, John Andrew, Sun Life Assurance Society, 60 Charing-cross, S.W.	1899**	Hudson, Alfred James, Northern Assurance Company, 1 Moorgate-street, E.C.
1869	Griffith, E. Clifton, 4 Carlton-chambers, S.W.		

ASSOCIATES.

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Date of becoming an Associate.		Date of becoming an Associate.	
1875	Hunt, Richard Aldington, F.S.S., <i>Wesleyan & General Assur. Soc., Corporation-street, Birmingham.</i>	1858	Kilford, George William, <i>Rue de Grétry, Paris.</i>
1893	Hunter, Arthur, F.F.A., <i>New York Life Insurance Co., 346 & 348 Broadway, New York.</i>	1874*	King, Arthur Thomas, <i>National Debt Office, Finsbury Pavement House, E.C.</i>
1887**	Hunter, Samuel, <i>Patriotic Assurance Company, 9 College-green, Dublin.</i>	1882**	King, William Alfred, <i>Northern Assurance Company, 1 Moorgate-street, E.C.</i>
1900**	Hurst, Henry Alexander, <i>485 Bury New-road, Kersal, Manchester.</i>	1861	Knowles, Richard, <i>35 Tilson-road, Tottenham, N.</i>
1889	Jacobs, Frederick Job, <i>Australian Mutual Provident Society, Sydney, Australia.</i>	1893**	Laing, William Claud, <i>Universal Life Assurance Soc., 1 King William-street, E.C.</i>
1876**	James, George Trevelyan, <i>12 Waterloo-place, S.W.</i>	1897**	Lane, Arthur Vere, B.A., <i>City of Glasgow Life Assurance Company, 12 King William-street, E.C.</i>
1871	Jellicoe, George Rogers, <i>Eagle Insurance Company, 79 Pall-mall, S.W.</i>	1899**	Lawton, George Herbert, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>
1883	Jerman, Richard, <i>Commercial Union Assurance Company, Exeter.</i>	1885	Ledward, Archibald Prentice, B.Sc., <i>29 Langland-gardens, N.W.</i>
1896**	Jobson, Alexander, <i>Australian Mutual Provident Society, Melbourne.</i>	1879	Leitch, Alexander, <i>Scottish Provident Institution, 17 King William-street, E.C.</i>
1894**	Johannessen, Nikolai Mikal, <i>Hygea Life Assurance Company, Bergen, Norway.</i>	1897**	Le Maitre, Frank William, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>
1894**	Johnston, Frederick H., <i>Prudential Life Insurance Co. of America, Newark, N.J., U.S.A.</i>	1885	Leveaux, Arthur Michael, F.S.S. (AUDITOR), <i>Registry of Friendly Societies, Central Office, 28 Abingdon-street, Westminster, S.W.</i>
1898**	Kaufman, Henry N., Assoc. Act. Soc. Amer., <i>Phoenix Mutual Life Insurance Co., Hartford, Connecticut.</i>	1885**	Lidbury, Isaac Stephen, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1876	Kearry, Joseph, <i>44 Charlwood-street, Belgrave-road, S.W.</i>	1868*	Litchfield, Edward, <i>Hessle Mount, Hessle, East Yorks.</i>
1899**	Kelly, John Joseph, <i>Citizens' Life Assurance Co., Sydney, Australia.</i>	1876**	Lucey, Herbert, <i>General Assurance Company, 103 Cannon-street, E.C.</i>
1897**	Kemp, Julian Ernest Sandford, <i>Eagle Insurance Company, 79 Pall-mall, S.W.</i>	1890	Lugton, Hugh, F.F.A., <i>North British and Mercantile Insurance Co., 61 Threadneedle-street, E.C.</i>
1901**a	Kennington, Charles William, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>		

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Date of becoming an Associate.	Date of becoming an Associate.
1867* Macdonald, William Rae, F.F.A., <i>Scottish Metropolitan Life Assur. Co., 25 St. Andrew-square, Edinburgh.</i>	1881 McKenzie, Duncan John McGregor, <i>New Zealand Government Life Insur. Department, Wellington, New Zealand.</i>
1884 Mackay, Alexander (AUDITOR), <i>Law Union & Crown Insur. Co., 126 Chancery-lane, W.C.</i>	1899** Meade, Gerald Willoughby, <i>North British & Mercantile Insurance Company, 61 Thread-needle-street, E.C.</i>
1901** Mackenzie, Michael Alexander, <i>Trinity College, Toronto, Canada.</i>	1896** Merfield, Percy Henry, <i>Law Life Assurance Society, 187 Fleet-street, E.C.</i>
1896** Macmillan, John Campbell, <i>Royal Insurance Co., Apartado Postal No. 657, Mexico.</i>	1874 Miller, John W., F.S.S., <i>Scottish Widows' Fund Life Assur. Soc., 28 Cornhill, E.C.</i>
1867 Macpherson, Ronald, <i>Law Union & Crown Insurance Co., 126 Chancery-lane, W.C.</i>	1884 Mills, Daniel Yarnton, <i>Scottish Equitable Life Assur. Society, 26 St. Andrew-square, Edinburgh.</i>
1883** Makeham, William Reed, <i>Imperial Life Insurance Co., 1 Old Broad-street, E.C.</i>	1879* Monilaws, William MacGeorge, <i>Scottish Provident Institution, 17 King William-street, E.C.</i>
1883 Mannering, George Willsher, <i>London & Lancashire Life Assur. Co., 66 and 67 Cornhill, E.C.</i>	1877 Moon, James, <i>Prudential Assurance Company, 30 Dale-street, Liverpool.</i>
1880* Manwaring, Henry, <i>National Debt Office, 19 Old Jewry, E.C.</i>	1877 Moon, John, <i>Prudential Assurance Company, 76 King-street, Manchester.</i>
1878 Marshall, William, <i>South African Mutual Life Assur. Soc., Cape Town, South Africa.</i>	1879* Moon, Sidney Norman Laming, <i>The Ocean Accident & Guarantee Corp., 346-348, Broadway, N.Y.</i>
1896** Martin, Sidney George, <i>National Mutual Life Assoc. of Australasia, Ltd., 150 Queen-street, Brisbane, Australia.</i>	1898** Moore, Joseph Patrick, <i>Citizens' Life Assurance Co., Sydney, Australia.</i>
1897** Mascall, Alfred John, <i>Standard Life Assurance Co., 3 Pall-mall East, S.W.</i>	1871** Moore, Roderick Mackenzie, <i>United Kingdom Temperance and General Provident Institution, 1 Adelaide-place, London-bridge, E.C.</i>
1900** Maunder, George Harvard, <i>Liverpool and London and Globe Insurance Co., 7 Cornhill, E.C.</i>	1893** Munro, Donald Alexander, <i>Brook House, 10 Walbrook, E.C.</i>
1898**a May, Basil, <i>National Mutual Life Assur. Soc., 39 King-street, Cheapside, E.C.</i>	1900** Nash, Alfred Charles, <i>Clerical, Medical and General Life Assurance Society, 15 St. James's-square, S.W.</i>
1900** McArthur, Harry de C., <i>Economic Life Assur. Society, 6 New Bridge-street, E.C.</i>	1897** Newling, Sidney Wallis, B.A., <i>Woodleigh, South Woodford, Essex.</i>
1882**a McDougald, Alfred, <i>British Empire Mutual Life Assur. Co., Montreal, Canada.</i>	

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Date of becoming an Associate.		Date of becoming an Associate.	
1884	Nicoll, John, F.F.A., <i>Life Association of Scotland,</i> 82 Princes-street, Edinburgh.	1900**	Peters, Charles Furness, <i>L'pool. Victoria Legal Friendly Society,</i> 18 St. Andrew-street, E.C.
1897**b	Norris, Charles Arthur, <i>National Mutual Life Assoc. of Australasia, Ltd.,</i> Melbourne, Australia.	1895	Pierson, Israel Coriell, Mem. Act. Soc. Amer., 141 Broadway, New York, U.S.A.
1900**	Oakley, Henry John Percy, <i>North British and Mercantile Insurance Company,</i> 61 Thread-needle-street, E.C.	1899**	Pipe, Sidney Herbert, <i>Independent Order of Foresters,</i> Temple-bldgs., Toronto, Canada.
1883	Orr, Lewis P., F.F.A., <i>Scottish Life Assur. Co., Ltd.,</i> 19 St. Andrew-sq., Edinburgh.	1883	Pitts, Thomas, <i>Commercial Union Assurance Company,</i> Exeter.
1886	Owen, Evan Frederick, F.S.S., <i>Actuary for Friendly Societies,</i> Melbourne, Australia.	1876*	Pound, Thomas James, <i>Clerical, Medical & General Life Assurance Soc.,</i> 15 St. James's-square, S.W.
1895**	Pagden, Lionel King, <i>Union Insurance Society,</i> 81 Cornhill, E.C.	1880	Povah, Charles, <i>Lancashire Insurance Company,</i> 18 Exchange-street, Manchester.
1864	Panton, Edward Henry, 50 Wood-vale, Forest Hill, S.E.	1890**	Powell, Alfred, <i>Alliance Assurance Company,</i> Bartholomew-lane, E.C.
1901**	Papps, Percy Charles Herbert, <i>Canada Life Assurance Company,</i> Toronto, Canada.	1881*	Price, William John, <i>Life Association of Scotland,</i> 5 Lombard-street, E.C.
1895**	Paradice, William Henry, <i>Australian Mutual Provident Society,</i> Sydney, Australia.	1869*	Pringle, James, C.A., F.F.A., 42 Drumsheugh-gardens, Edinburgh.
1869*	Park, David Francis, C.A., F.F.A., <i>Credit Foncier of Mauritius (Limited),</i> 39 Lombard-st., E.C.	1884	Pullar, James, F.F.A., <i>Colonial Mutual Life Assurance Society,</i> Melbourne, Australia.
1884	Park, Leslie John, <i>Colonial Mutual Life Assurance Society,</i> Melbourne, Australia.	1881	Purves, Thomas Peter, <i>New York Life Insurance Company,</i> Sydney, Australia.
1882**	Paterson, William Brockie, F.F.A., Mem. Act. Soc. Amer., <i>Norwich Union Life Insurance Society,</i> Norwich.	1899**	Rac, Joseph, <i>Finance Department,</i> Town-hall, Upper-street, N.
1898	Pearee, Henry John, F.F.A., <i>Edinburgh Life Assurance Co.,</i> 122 St. Vincent-street, Glasgow.	1867	Ratray, Patrick, C.A., <i>Gresham House,</i> 45 West Nile-street, Glasgow.
1899**	Peele, Thomas, <i>Refuge Assurance Company,</i> Oxford-street, Manchester.	1874**	Ray, Charles Richard, <i>Hand-in-Hand Insurance Soc.,</i> 26 New Bridge-street, E.C.
1901**	Penman, William, <i>Northern Assurance Company,</i> 1 Moorgate-street, E.C.	1885*	Rea, Charles Herbert Edmund, F.R.A.S., F.S.S., 3 & 4 Clement's-inn, W.C.
1875	Perratt, William Henry, 4 Finsbury-circus, E.C.	1898**	Reid, Edward E., B.A., <i>London Life Insurance Co.,</i> London, Ontario.

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Date of becoming an Associate	Date of becoming an Associate.
1901** Rhodes, Francis, B.A., <i>Royal Insurance Company, Liverpool.</i>	1894**a Sheppard, Herbert Norman, B.A., <i>Union Central Life Office, Cincinnati, Ohio, U.S.A.</i>
1887 Richardson, Josephus Hargreaves, F.F.A., Mem. Act. Soc. Amer., <i>New Zealand Government Life Insurance Department, Wellington, New Zealand.</i>	1899** Sherriff, Francis Henry, <i>Provident Clerks' Mutual Life Assurance Association, 27 & 29 Moorgate-street, E.C.</i>
1900**a Richmond, George William, <i>Scottish Widows' Fund Life Assur. Society, 28 Cornhill, E.C.</i>	1897** Shimmell, James Edward, <i>Scottish Imperial Insurance Co., 183 West George-st., Glasgow.</i>
1879 Roberts, Thomas B., <i>Australian Alliance Assurance Company, Collins-street, Melbourne, Australia.</i>	1896** Shlager, Joseph, <i>Mutual Assurance Society, Melbourne, Australia.</i>
1878 Robertson, William, F.F.A., <i>54 Queen-street, Edinburgh.</i>	1897** Slade, Henry, <i>27 Balkam-grove, S.W.</i>
1876* Robinson, Andrew, <i>Sunningdale-park, Sunningdale, Berks.</i>	1864* Smith, Howard Samuel, F.F.A., F.S.S., F.C.A., <i>Bank-chambers, 11 Waterloo-street, Birmingham.</i>
1885 Ronald, Thomas Robert, <i>Law Guarantee and Trust Soc., Ltd., 49 Chancery Lane, W.C.</i>	1898** Smith, Robert Parker, <i>Royal Insurance Company, 1 North John-street, Liverpool.</i>
1897** Ryley, Edmund, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1884 Smithett, Edward Henry, <i>"Hillside," Fitzroy-park, Highgate, N.</i>
1896** Sanderson, Frank, M.A., F.S.S., Mem. Act. Soc. Amer., <i>Canada Life Assurance Company, Toronto, Canada.</i>	1871 Spencer, Robert James, F.S.S., <i>75 King's-road, Southsea.</i>
1884 Schooling, John Holt, <i>Fotheringay-house, Montpelier-row, Twickenham.</i>	1868 Spens, William George, <i>Scottish Amicable Life Assur. Soc., 35 St. Vincent-pl., Glasgow.</i>
1899** Schouten, Pieter, <i>Algemeene Maatschappij van Levensverzekering en Lijfrente, Damrak, 74, Amsterdam.</i>	1860* Stark, James, <i>Reversionary Interest Society, 30 Coleman-street, E.C.</i>
1873 Scott, Ernest Willem, Mem. Act. Soc. Amer., <i>Algemeene Maatschappij van Levensverzekering en Lijfrente, Damrak, 74, Amsterdam.</i>	1866 Stark, William Emery, F.S.S., <i>Chapel-walks, Manchester.</i>
1861** Searle, Thomas John, <i>Mansion-house-chambers, Bucklersbury, E.C.</i>	1878 Stevenson, Charles, <i>9 Albert-square, Manchester.</i>
1900** Searls, Edwin Richard, <i>Northern Assurance Company, 1 Moorgate-street, E.C.</i>	1880 Stock, Edward James, <i>National Mutual Life Assoc. of Australasia, Melbourne, Australia.</i>
1900** Sharpe, Edgar Cecil Engledue, <i>London Life Association, Ltd., 81 King William-street, E.C.</i>	1895**b Strong, William Richard, <i>London Guarantee & Accident Co., 61 Moorgate-street, E.C.</i>
	1896** Stuckey, Jos. James, M.A., <i>Salisbury Chambers, 49a King William-street, Adelaide, South Australia.</i>

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Date of becoming an Associate.		Date of becoming an Associate.	
1869	Surrenne, David John, F.F.A., 29 Inverleith-road, Edinburgh.	1884	Vincent, Frederick James, F.S.S. London, Edinburgh & Glasgow Assurance Co., Ltd., Insurance- buildings, Farringdon-street, E.C.
1899**	Symmons, Frank Percy, Prudential Assurance Company, Holborn-bars, E.C.	1899**	Vokins, George Alfred, Prudential Assurance Company, Holborn-bars, E.C.
1882	Tarn, Walter George, Reversionary Interest Society, 30 Coleman Street, E.C.	1883**	Walker, Davidson, F.F.A., Norwich Union Life Assurance Society, Norwich.
1893**	Taylor, Arthur, Westminster and General Life Assurance Assoc., 28 King-street, Covent-garden, W.C.	1879*	Wall, Walter George, 3 Shrewsbury-road, Birkenhead.
1875	Taylor, J. Wilford, North British and Mercantile Insur. Co., 61 Threadneedle-st., E.C.	1878	Walton, William Gandy, F.F.A., Scottish Provident Institution, 6 St. Andrew-square, Edinburgh.
1898**	Thompson, Thomas Percy, B.A., British Empire Mutual Life Assurance Co., 4 & 5 King William-street, E.C.	1862*	Waterhouse, Edwin, M.A., F.C.A., F.S.S., 3 Frederick's-place, Old Jewry, E.C.
1899**	Tinner, Thomas, Comptroller's Depart., London County Council, Spring-gardens, S.W.	1883**	Watson, John Robertson, British Law Fire Insurance Co., 176 West George-st., Glasgow.
1883**	Titmuss, Walter George, Provident Life Assurance Co., 50 Regent-street, W.	1887	Watson, Reuben, Manchester Unity Friendly Soc., Nottingham.
1883*	Tregaskis, George Alfred, Hand-in-Hand Assurance Soc., 26 New Bridge-street, E.C.	1894**	Watt, George, Royal Insurance Co., Liverpool.
1894**	Trenerry, Charles Farley, B.A., F.S.S., 3 North-road, Clapham-park, S.W.	1900	Watt, James, F.F.A., 28 Charlotte-square, Edinburgh.
1869**	Trew, Edward Bellingham, Law Life Assurance Society, 187 Fleet-street, E.C.	1883*	Weall, Bertram, 16 Waldegrave-park, Twicken- ham.
1891**	Turnbull, A. D. Lindsay, C.A., F.F.A., Commercial Union Assurance Co., 24, 25 & 26 Cornhill, E.C.	1899**	Weatherill, Henry, National Debt Office, Finsbury Pavement House, E.C.
1877**	Turpin, William Gibbs, National Debt Office, Finsbury Pavement House, E.C.	1894	Weeks, Rufus Wells, Mem. Act. Soc. Amer., New York Life Insurance Co., 346 & 348 Broadway, New York.
1884	Vian, William Collett, Railway Passengers' Assurance Company, 64 Cornhill, E.C.	1898**	Whigham, Charles Frederick, F.F.A., Messrs. Moncrieff & Horsburgh, 46 Castle-street, Edinburgh.
		1884	Whyte, Alexander, c/o Messrs. Lever Bros., Ltd., Port Sunlight, Cheshire.

ASSOCIATES.

Those marked * have passed the first of the three parts of the Examination for the Class of Fellow. Those marked * have passed two of the three parts of the Examination for the Class of Fellow; those marked * a or * b, have also passed either Section A or Section B of Part III of the Examination.

Date of becoming an Associate.		Date of becoming an Associate.	
1897**	Wickens, Charles H., <i>Registrar-General's Office, Perth, W. Australia.</i>	1875	Woods, Edward, <i>Victoria Life and General Insur. Co., Market-street, Collins-street-west, Melbourne, Australia.</i>
1896**	Wilkinson, Edward Berkeley, <i>12 Highlever-road, N. Kensington, W.</i>	1897**	Woolfe, Archibald William, B.A., <i>42 Church-crescent, Muswell-hill, N.</i>
1900**	Wilson, George, <i>Standard Life Assurance Company, Edinburgh.</i>	1898**	Woolmer, Alfred Henry, <i>Star Life Assurance Society, 32 Moorgate-street, E.C.</i>
1870**	Wilson, Henry Edward (AUDITOR), <i>Northern Ass. Co., 1 Moorgate-street, E.C.</i>	1898**	Workman, William Arthur, <i>Equitable Life Assur. Society, Mansion-house-street, E.C.</i>
1901**	Wilson, John Sydney, <i>Australian Widows' Fund Life Assurance Society, Melbourne, Australia.</i>	1879*	Wornum, Thornton Selden, <i>Rock Life Assurance Company, 15 New Bridge-street, E.C.</i>
1873**	Windett, Charles, <i>Legal & General Life Assur. Soc., 10 Fleet-street, E.C.</i>	1893**	Wright, Robert Young Murray, M.A., <i>Royal Insurance Co., Charing-cross, Birkenhead.</i>
1898**	Wood, Arthur Barton, B.A., Asso. Act. Soc. Amer., <i>Sun Life Assurance Co. of Canada, Montreal, Canada.</i>	1871	Yardley, John, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1883	Woodhouse, Lister, A.C.A., <i>City Comptroller, Town-hall, Westminster, S.W.</i>	1873	Young, Alexander Hunter, <i>60 Market-street, Melbourne, Australia.</i>
1877**	Woods, Arthur Biddle, <i>Rock Life Assurance Company, 15 New Bridge-street, E.C.</i>	1900**	Young, Arthur Stanley, <i>Commercial Union Assurance Co., 24, 25 & 26 Cornhill, E.C.</i>
1866	Woods, Bernard, <i>Metropolitan Life Assur. Soc., 13 Moorgate-street, E.C.</i>		

STUDENTS.

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Date of becoming a Student.		Date of becoming a Student.	
1892*	Aaron, David Hyam, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>	1900*	Baxter, Edwin Herbert, <i>Scottish Provident Institution, 17 King William-street, E.C.</i>
1894*	Anderson, Adam Thomson, <i>Australian Mutual Provident Society, Sydney, Australia.</i>	1901*	Beddall, H. Muir, <i>Ocean Accident and Guarantee Corporation, 11 Pall Mall, S.W.</i>
1886	Arnold, Thomas, Jun., <i>British Equitable Life Assurance Company, Queen-street-place, E.C.</i>	1900*	Bell, Henry Soady, <i>"Netherhall," The Drive, Sidcup, Kent.</i>
1896*	Ashley, Charles Henry, <i>Refuge Assurance Company, Oxford-street, Manchester.</i>	1898*	Bennell, Samuel Thomas, <i>20 Narford-road, Brooke-road, Clapton, N.E.</i>
1901*	Atkins, Leonard George, <i>Law Union & Crown Insurance Co., 126 Chancery-lane, W.C.</i>	1898*	Bennett, Samuel, <i>National Deposit Friendly Soc., 11 Red Lion-square, Holborn, W.C.</i>
1899*	Baber, Walter Crosbie, <i>Sun Life Assurance Co. of Canada, Montreal.</i>	1895*	Bigby, Robert Frederick Mitchell, <i>General Assurance Company, 103 Cannon-street, E.C.</i>
1897*	Backett, William Albert, <i>London and Lancashire Fire Insurance Company, 73-76 King William-street, E.C.</i>	1900*	Bingeman, Milton H., <i>The Great West Life Assurance Company, Winnipeg, Manitoba, Canada.</i>
1898**	Bacon, James, <i>c/o Messrs. Ackland & Rea, 3 and 4 Clements-inn, W.C.</i>	1891*	Bird, Edward William, <i>Northern Assurance Company, 1 Moorgate-street, E.C.</i>
1896**	Ball, Sidney Robertson, <i>English and Scottish Law Life Assurance Association, 12 Waterloo-place, S.W.</i>	1898*	Bishop, Harold Garfield, <i>Northern Assurance Company, 1 Moorgate-street, E.C.</i>
1897	Barfield, Edmund John, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1898*	Blake, Frederick Edward, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1899*	Barnett, Isaac, <i>Universal Life Assurance Soc., 1 King William-street, E.C.</i>	1901*	Blake, Francis Seymour, <i>62 Oakhurst-grove, East Dulwich, S.E.</i>
1899*	Barrett, William Goodsman, <i>34 Penge-road, South Norwood, S.E.</i>	1898*	Blake, Henry Prince, <i>Union Insurance Society, 81 Cornhill, E.C.</i>
1896*	Barry, David, <i>Office of the Actuary for Friendly Societies, Melbourne, Australia.</i>	1895	Blanch, Frederick William, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>

STUDENTS.

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Date of becoming a Student.		Date of becoming a Student.	
1901*	Blehl, Ernest M., A.M., <i>Penn. Mutual Life Insurance Co., Philadelphia, U.S.A.</i>	1901*	Caldwell, Richard H., <i>North British & Mercantile Insurance Co., Birmingham.</i>
1887	Blossom, James, <i>186 South-view-road, Sheffield.</i>	1901*	Carter, George Stanley, <i>Life Association of Scotland, 5 Lombard-street, E.C.</i>
1892*	Boddy, Henry Mitchell, <i>Imperial Life Assurance Co. of Canada, 58 Sparks-street, Ottawa, Canada.</i>	1899*	Carter, Norman John, <i>Eagle Insurance Company, 79 Pall-mall, S.W.</i>
1897	Bond, Frederic D., <i>122 South 39th Street, Philadelphia, U.S.A.</i>	1900*	Chambers, John Joseph, <i>1 Church-street, Southport.</i>
1900*	Borrajo, Edward Joseph William, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1899*	Cherry, Christopher F., <i>Citizens' Life Assurance Co., Sydney, Australia.</i>
1897*	Bowles, Francis Marsh, <i>Pearl Life Assurance Company, London Bridge, E.C.</i>	1894	Child, Frank Edward, <i>Fern Bank, Aston Fields, Broms-grove, Birmingham.</i>
1891*	Boyd, Henry Norris, <i>City of Glasgow Life Assurance Co., 21 St. Andrew-square, Edinburgh.</i>	1901*	Chubb, William, <i>Sun Life Assurance Company of Canada, Montreal, Canada.</i>
1899*	Brady, John Francis, <i>Citizens' Life Assurance Co., Sydney, Australia.</i>	1901*	Clarke, Eustace Edgar, <i>British Empire Mutual Life Assurance Co., 4 & 5 King William-street, E.C.</i>
1901*	Bree, John, <i>National Debt Office, 19 Old Jewry, E.C.</i>	1901	Clements, Henry, B.A., <i>Star Life Assurance Society, 31 Lincoln's-inn-fields, W.C.</i>
1897*	Brierley, William Ernest, <i>Refuge Assurance Company, Oxford-street, Manchester.</i>	1897*	Clinton, George, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1893*	Briggs, Frederick William, <i>Caxton-villa, Wood-green, N.</i>	1901*	Cockerton, John Leonard, <i>The Pioneer Life Assurance Co., Ltd., 11 Dale-street, Liverpool.</i>
1894*	Brough, Frank, <i>Federal Life Assurance Company, Hamilton, Ontario.</i>	1895	Cogar, William Edward, <i>New York Life Insurance Co., Trafalgar-square, W.C.</i>
1891*	Brown, William Heron, <i>Gresham Life Assurance Society, Limited, St. Mildred's-house, Poultry, E.C.</i>	1898*	Collier, Charles Aubrey, <i>46 Crockerton-road, Tooting, S.W.</i>
1889	Buckle, Frederick, <i>68 Belleville-road, Wandsworth-common, S.W.</i>	1895**a	Collins, Frank Lakeman, <i>Clerical, Medical & General Life Assurance Soc., 15 St. James's-square, S.W.</i>

STUDENTS.

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Date of becoming a Student.		Date of becoming a Student.	
1899*	Collins, Patrick A., <i>Citizens' Life Assurance Co., Sydney, Australia.</i>	1891	Daniell, Ferrers Aitken, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>
1891	Colvin-Smith, Colvin Arthur Edward, <i>North British and Mercantile Insurance Co., 61 Threadneedle-street, E.C.</i>	1896*	Davey, Clarence, <i>4 Oakfield-road, Finsbury-pk., N.</i>
1896*	Cook, Henry Milton, <i>Standard Life Assurance Company, Dalhousie-square, Calcutta, India.</i>	1889*	Davies, Hugh Myddelton, <i>Royal Insurance Co., Liverpool.</i>
1900*	Cooper, Bernard Hugh, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1901	Davies, T. Ridler, B.A., <i>1143 Dorchester-street, Montreal, Canada.</i>
1899*	Cotterill, William Ernest, <i>Mutual Life Assoc. of Australasia, Ltd., Sydney, Australia.</i>	1900*	Davies, William Allison, <i>13 Ash Leigh, Anfield, Liverpool.</i>
1897**	Court, Alexander George Dacus, <i>4 Langdale-road, Greenwich, S.E.</i>	1899*	Davison, Horace Williams, <i>Manufacturers' Life Insurance Co., Toronto, Canada.</i>
1901*	Coventry, Cameron H., <i>Clerk-street, Wayville, Adelaide, South Australia.</i>	1891*	Dawson, Frank Aubrey, <i>Ecclesiastical Insurance Office, Limited, 11 Norfolk-street, Strand, W.C.</i>
1896	Cox, Charles, <i>129 Cannon-street, E.C.</i>	1901*	Dawson, Miles Menander, F.S.S., <i>11 Broadway, New York, U.S.A.</i>
1894	Cox, Edward William, <i>Canada Life Assurance Co., Toronto, Canada.</i>	1899*	De Lury, George, <i>Manilla, Ontario, Canada.</i>
1894	Coz, Herbert Coplin, <i>Canada Life Assurance Co., Toronto, Canada.</i>	1901	Denmead, John Charles, M.A., <i>Estate Duty Office, Somerset House, W.C.</i>
1896	Critchley, George Francis, <i>18 Handen-road, Lee, S.E.</i>	1901*	Dent, Ernest Edward, <i>London & Lancashire Life Assurance Co., 66 & 67 Cornhill, E.C.</i>
1887*	Cross, Henry John, <i>3 Park-rd., Wandsworth-common, S.W.</i>	1896*	de Ville, Francis, <i>Clergy Pensions Institution, 11 Norfolk-street, Strand, W.C.</i>
1897*	Crump, Percy C., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1897*	Dick, William Thos., B.A., M.L.A., <i>Newcastle, N.S.W.</i>
1897*	Dalton, John, <i>London Life Association, Ltd., 81 King William-street, E.C.</i>	1895*	Dickinson, Frank Ridley, <i>2 Tubbs-road, Harlesden, N.W.</i>
		1890*	Doeker, Leslie, <i>North British and Mercantile Insurance Co., 61 Threadneedle-street, E.C.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1897*	Dorrian, John Christopher, <i>Citizens' Life Assurance Company, Sydney, Australia.</i>	1901*	Ferguson, Colin C., <i>Canada Life Assurance Co., Toronto, Canada.</i>
1899*	Douglas, J. Joseph, <i>Irish Land Commission, 24 Upper Merrion-street, Dublin.</i>	1901*	Fielder, William Crowhurst, <i>National Mutual Life Assurance Society, 39 King-street, Cheapside, E.C.</i>
1893*	Doust-Smith, Ernest Charles, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1887	Fisher, Hugh Strettell, <i>1 Arcoa-terrace, Blackrock, co. Dublin.</i>
1900*	Doust, William Frederick, <i>National Debt Office, 19 Old Jewry, E.C.</i>	1901*	Fisher, John William, <i>Manufacturers' Life Insurance Co., Toronto, Canada.</i>
1901*	Downes, Sidney Cecil, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1896*	Fisk, George William Victor, F.S.S., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1897*	Ecroyd, Cuthbert W., <i>Friends' Provident Institution, Bradford.</i>	1901*	FitzGerald, Charles R., <i>Home Life Association of Canada, Toronto, Canada.</i>
1891	Edlmann, Herbert Elliot, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>	1901*	Franklin, Herbert Dare, <i>Australian Mutual Provident Society, Melbourne, Australia.</i>
1892	Edwards, Edward Samuel, <i>Australian Mutual Provident Society, Sydney, Australia.</i>	1901*	Gaines, John M., <i>New York Life Insurance Co., 346 Broadway, New York, U.S.A.</i>
1892*	Eedy, Arthur Malcolm, <i>Citizens' Life Assurance Company, Sydney, Australia.</i>	1890	Gamman, Robert Ebenezer, <i>London Joint Stock Bank, Princes-street, E.C.</i>
1901*	Egleton, Harold Edward, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1886	Garcke, Emile, F.S.S., M.I.E.E., <i>Sunnyside, Bedford-park, W.</i>
1900*	Elderton, Robert Lapidge, <i>National Provident Institution, 48 Gracechurch-street, E.C.</i>	1900*	Garner, James, <i>9 Arlington Park-gardens North, Chiswick, W.</i>
1893*	Emery, John M., <i>American Union Life Insurance Co., Bowling Green-building Broadway, New York.</i>	1901*	Gemmell, William, <i>7 Royal-terrace, Queen's-park, Glasgow.</i>
1892*	Farrell, John, <i>Citizens' Life Assur. Co., 210 Queen-st., Brisbane, Australia.</i>	1901	Gerrish, Frank Wilfred, <i>2 Fell-street, Wood-street, E.C.</i>
1886	Fells, John Manyer, F.S.S., <i>85 Gracechurch-street, E.C.</i>	1899*	Giles, Hylton Lloyd, <i>British Empire Mutual Life Assurance Co., 4 & 5 King William-street, E.C.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1895*	Gill, James Stewart, <i>Australian Widows' Fund Life Assurance Society, Melbourne, Australia.</i>	1899*	Gray, Robert Alexander, B.A., <i>Northern Life Assurance Co., London, Ontario, Canada.</i>
1900*	Gillespie, Joseph Hugh Ross, M.A., <i>Manufacturers' & Temperance & General Life Assurance Co., Toronto, Canada.</i>	1900*	Green, James Proctor, <i>Refuge Assurance Co., Oxford-street, Manchester.</i>
1901*	Glassford, David Murray, <i>Mutual Life Association of Australasia, Sydney, N.S.W., Australia.</i>	1886	Greening, Herbert Joseph, <i>Abstainers & General Insur. Co., City-buildings, Birmingham.</i>
1893	Glasson, George Cornish, <i>Economic Life Assurance Soc., 4 St. Stephen's-chbrs., Baldwin-street, Bristol.</i>	1899*	Grigg, Benjamin, <i>Sun Life Assur. Co. of Canada, Montreal, Canada.</i>
1893*	Gledstone, W. L., <i>Royal Exchange Assur. Corporation, Royal Exchange, E.C.</i>	1899*	Guest, Smith Austin, <i>Pen-y-Bryn, Bangor, North Wales.</i>
1897*	Goddard, Egbert, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1901*	Hall, Arthur F., <i>North American Life Assurance Co., North American Life Building, 112-118 King-street-west, Toronto, Canada.</i>
1894*	Golding, Arthur, <i>41 Digby-rd., Finsbury-park, N.</i>	1900*	Hall, John Bertram, <i>Imperial Life Assurance Co. of Canada, Toronto, Canada.</i>
1888*	Gooding, Harold John, <i>Law Guarantee and Trust Soc., Ltd., 56 Moorgate-street, E.C.</i>	1896*	Hallman, M. S., <i>The Mutual Life Assurance Co. of Canada, Waterloo, Ontario.</i>
1900*	Goodman, Gilbert, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1899*	Halloran, George Henry, <i>Australian Mutual Provident Society, Sydney, Australia.</i>
1892	Gordon, Alexander, <i>168 Islington, Liverpool.</i>	1901*	Hamilton, George Powell, <i>North American Life Assurance Co., North American Life Building, 112-118 King-street-west, Toronto, Canada.</i>
1896*	Gordon, Harry Duncan Lockhart, <i>221 George-st., Toronto, Canada.</i>	1900*	Hammond, Reginald, <i>British Equitable Life Assur. Co., Queen-street-place, E.C.</i>
1897**	Gosset, Thorold, <i>21 Old-bldgs., Lincoln's-inn, W.C.</i>	1892	Hancock, Arthur Tom, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>
1886	Gover, Frederick Field, F.S.S., <i>10 Lee-park, Blackheath, S.E.</i>	1895*	Harding-Newman, Thomas Harold, <i>Scottish Amicable Life Assur. Soc., 1 Threadneedle-street, E.C.</i>
1895*	Grant, Kenneth Stuart, <i>Alliance Assurance Company, 1 Bartholomew-lane, E.C.</i>		
1901*	Grant, Milton Daniel, B.A., <i>Government Insurance Department, Ottawa, Canada.</i>		

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Date of becoming a Student.		Date of becoming a Student.	
1901*	Harpell, James John, <i>Queen's University Journal, Box 141, Kingston, Ontario, Canada.</i>	1896*	Hogg, Charles, <i>10 Whitehall-place, s.w.</i>
1901*	Harper, Henry, <i>96, Byron-road, Birmingham.</i>	1894	Holdsworth, David Armdell, <i>Star Life Assurance Society, 22 Eldon-square, Newcastle-on-Tyne.</i>
1895*	Harper, Sidney, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1898*	Hooper, George Duncan, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1889*	Harris, Henry, <i>Friends' Provident Institution, Bradford.</i>	1895**	Horn, Ernest Frederick, <i>The Bolttons, Sidcup, Kent.</i>
1897*	Harriss, Walter James, <i>Life Association of Scotland, 5 Lombard-street, E.C.</i>	1901*	Howell, Archibald Rennie, B.A., <i>Royal Victoria Life Insur. Co. of Canada, Montreal, Canada.</i>
1896	Haskins, George Frederick, A.C.A., <i>2 Westbourne-road, Newlands-park, Sydenham, s.e.</i>	1898	Hughes, Arthur J., <i>The Crown Life Insurance Co., Toronto, Canada.</i>
1894*	Hatten, David Leslie, <i>Standard Life Assurance Co., 3 George-street, Edinburgh.</i>	1900*	Hughes, Arthur Sidney, <i>6 Telford-avenue, Streatham-hill, s.w.</i>
1897*	Hay, John Dalziel, <i>Crown Lands Office, Wellington, New Zealand.</i>	1897*	Humphrey, Bernard, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1892	Hellyer, Arthur Lee, <i>Shannon-court, Bristol.</i>	1901*	Humphreys, Henry Thompson, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>
1897*	Hepburn, Charles James, <i>Clerical, Medical and General Life Assurance Society, Mansion House-buildings, E.C.</i>	1891	Hunt, Arthur Leonard, <i>Wesleyan and General Assur. Society, 18 New Bridge-st., E.C.</i>
1891	Higinbotham, Harry Newburgh, <i>Royal Exchange Assur. Corporation, Royal Exchange, E.C.</i>	1899*	Hunter, Robertson G., <i>New York Life Insur. Co., 346 & 348 Broadway, New York.</i>
1901*	Hilary, Henry Jephson, <i>Dryhill-park, Tonbridge.</i>	1899*	Jackaman, Arthur Fredk. Samuel, <i>National Mutual Life Assur. Soc., 39 King-street, Cheapside, E.C.</i>
1896**	Hines, Walter Robert, <i>Norwich Union Life Office, Norwich.</i>	1890**	Jackson, Samuel, <i>Scottish Widows' Fund Life Assurance Society, Liverpool.</i>
1897	Hitchins, William Richmond, B.A., <i>Manufacturers' Life Insurance Company, Toronto.</i>	1900**	Jarman, William Rees, B.A., <i>National Debt Office, Finsbury Pavement House, E.C.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1895*	Jenkyn, John, <i>Ocean Accident & Guarantee Corp., 40-44 Moorgate-st., E.C.</i>	1899*	Kissau, Edgar Duguid, <i>Atlas Assurance Company, 92 Cheapside, E.C.</i>
1896*	Jepps, John Blacklee, <i>English and Scottish Law Life Assurance Assoc., 12 Waterloo-place, S.W.</i>	1895*	Knight, Alfred Murray, <i>Bank-house, Chapel-st., Devon-port.</i>
1898*	Johnston, Arthur Edward, <i>3 Cumnor-road, Sutton.</i>	1897	Krause, Holger Erasme, <i>Prudential Insurance Company of America, Newark, N.J., U.S.A.</i>
1898	Johnston, James O., <i>Law Union & Crown Insur. Co., 126 Chancery-lane, W.C.</i>	1895	Laing, Oswald George, <i>North British and Mercantile Insurance Co., Park-row, Leeds.</i>
1899*	Jones, Leonard Alexander Mouat, <i>Hand-in-Hand Insur. Society, 26 New Bridge-street, E.C.</i>	1901*	Latham Bertrand, <i>Australian Mutual Provident Society, Melbourne, Australia.</i>
1896*	Jones, Richard Foxley, <i>Refuge Assurance Co., Oxford-street, Manchester.</i>	1890*	Lawson, Henry Graham Steuart, <i>Scottish Accident Insur. Co., Ltd., 115 George-street, Edinburgh.</i>
1896*	Jones, Wallace Mouat, <i>General Reversionary & Investment Company, Limited, 26 Pall-mall, S.W.</i>	1891	Layzell, Phillip Cuddington, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1893**	Kelham, Cyril Stephen, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1901*	Leigh, Samuel George, <i>Refuge Assurance Co., Oxford-street, Manchester.</i>
1900*	Kennedy, Edward Robert, <i>National Debt Office, 19 Old Jewry, E.C.</i>	1893	Le Maistre, Charles H., <i>Penn Mutual Life Insurance Co., Philadelphia, U.S.A.</i>
1898	Kidson, Leonard Douglas, <i>15 Roe-lane, Southport.</i>	1894	Leonard, Maurice, <i>14 Sotheby-rd., Highbury, N.</i>
1900*	Kilgour, David Errett, <i>North American Life Assur. Co., North American Life Building, 112-118 King-st.-west, Toronto, Canada.</i>	1896*	Ley, James, <i>Office of the Actuary for Friendly Societies, Melbourne, Australia.</i>
1894**	Kingsbury, James William, <i>Australian Mutual Provident Society, Sydney, Australia.</i>	1889*	Lighton, Harold John, <i>Law Union & Crown Insurance Co., 126 Chancery-lane, W.C.</i>
1900*	Kirkham, Alfred, <i>229 Chapel-street, Prahran, Victoria, Australia.</i>	1895*	Littell, Lewis Lloyd, <i>Standard Life Assurance Co., 83 King William-street, E.C.</i>
		1890	Love, Robert, <i>Pelican Life Insurance Company, 70 Lombard-street, E.C.</i>
		1894	Lucey, Frederick Samuel, F.C.A., <i>15 George-street, Mansion-house, E.C.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1901*	Macmillan, Alexander, <i>Westfield House, Westgate-hill, Bradford.</i>	1894*	Mills, Thomas Percy, <i>Mutual Life Association of Australasia, Wellington, New Zealand.</i>
1896	Marlow, Thomas Gibbons, A.I.S., <i>13 St. Roman's-road, Abbeydale, Sheffield.</i>	1899**	Minns, Ernest Edwin, <i>Norwich Union Life Office, Norwich.</i>
1893*	Martin, William Anderson, M.A., <i>Scottish Provident Institution, Dublin.</i>	1897	Mirams, Arthur Greyford, <i>Australian Temperance & General Life Assurance Soc., Melbourne, Australia.</i>
1900*	May, Walter Thomas, <i>Scottish Amicable Life Assurance Society, 1 Threadneedle-st., E.C.</i>	1898*	Moore, George Cecil, <i>Imperial Life Insurance Co. of Canada, Toronto, Canada.</i>
1895*	Mayhew, Percy Craske, <i>Westminster and General Life Assurance Assoc., 28 King-st., Covent-garden, W.C.</i>	1900*	Moore, George Edward, <i>Australian Widows' Fund Life Assurance Company, Melbourne, Australia.</i>
1888*	McConway, James Robert, <i>Royal Insurance Company, Liverpool.</i>	1895*	Moore, Gerald Leslie, A.C.A., <i>58 Coleman-street, E.C.</i>
1895	McLeod, James Stirling, <i>c/o Messrs. Williams & Kettle, Ltd., Napier, New Zealand.</i>	1898*	Moore, Stanley, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1897*	McPhail, Frederick Charles, <i>Colonial Mutual Life Assurance Society, Limited, Melbourne, Australia.</i>	1895*	Morgan, George Frederick Hughes, <i>Law Guarantee & Trust Society, 49 Chancery-lane, W.C.</i>
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1897*	Melville, Charles Edward, <i>274 The Avenue, Royal Park, Melbourne, Australia.</i>	1896	Morrison, Hubert Peter, <i>37 New-street, Birmingham.</i>
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1892*	Meyers, Henry Wilson, <i>National Mutual Life Association of Australasia, Melbourne, Australia.</i>	1900**	Neill, Samuel Bennett, <i>"Oakwood," Southend-road, Beckenham, Kent.</i>
1896*	Milligan, Charles Livingstone, <i>Provident Life Office, 50 Regent-street, W.</i>	1895*	Newnham, Ernest Whiffin, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>

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Date of becoming a student.		Date of becoming a student.	
1897	Nicholls, Robert James, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>	1898	Peirson, Percy F., <i>17 Hertford-street, Coventry.</i>
1900*	Norsworthy, Edward C., <i>The Dominion Securities Corporation, Limited, Canada Life Building, Montreal, Canada.</i>	1896**	Penny, Charles Augustus, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
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1901*	Nugent, James, <i>Cornwall, Ontario, Canada.</i>	1898*	Pigrome, George Davey, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1891	O'Neill, Harry Duncan, <i>Clerical, Medical & General Life Assurance Society, 36 Park-row, Leeds.</i>	1898	Poort, Willem Anthonie, Phil. Nat. Doct., <i>Middelberg, Holland.</i>
1892*	O'Reilly, Anthony James, <i>Government Insurance Department, Ottawa, Canada.</i>	1892*	Powell, Harold Charlesworth, <i>Equitable Life Assurance Soc., Mansion-house-street, E.C.</i>
1897*	Osborn, Nathaniel Banner Francis, <i>11 Bruce-grove, Tottenham, N.</i>	1893*	Pownall, Herbert Wilfred, <i>Australian Mutual Provident Society, Adelaide, Australia.</i>
1893*	Owen, Edgar Theodore, F.S.S., <i>Registrar of Friendly Societies, Perth, Western Australia.</i>	1898*	Pring, Arnold Lyddon, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1901*	Papworth, Frederick William, <i>Cyril Villa, Wilton-rd., Merton, Surrey.</i>	1897	Proctor, Jr., William, <i>Refuge Assurance Company, Oxford-street, Manchester.</i>
1891*	Parisot, Oscar, <i>71 Fleet-street, E.C.</i>	1886*	Quick, John Richard, <i>Equity & Law Life Assur. Soc., 18 Lincoln's-inn-fields, W.C.</i>
1895*	Pascoe, William Yeoman Bennett, <i>Prudential Assurance Company, Holborn-bars, W.C.</i>	1901*	Ramsay, Cecil Byron, <i>Mutual Life Insurance Co. of New York, 16, 17 & 18 Cornhill, E.C.</i>
1901*	Paton, Albert George, <i>c/o Messrs. Weaver & Perry, 164 Pitt-street, Sydney, N.S.W., Australia.</i>	1898	Reynell, Guy Courtenay, <i>National Mutual Life Assurance Society, 39 King-st., Cheapside, E.C.</i>
1897	Paton, Harry Arthur, <i>Royal Exchange Assurance Corporation, Royal Exchange, E.C.</i>	1894*	Richards, Gilbert P. A., <i>Royston-villa, New Barnet.</i>
		1894**	Rietschel, Hermann Julius, <i>Sun Life Assurance Society, 63 Threadneedle-street, E.C.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1901*	Robertson, A. W. L., <i>Liverpool and London and Globe Insurance Co., 7 Cornhill, E.C.</i>	1897	Sawtell, John A., <i>Law Accident Insurance Society, 215 Strand, W.C.</i>
1898	Robertson, Douglas Gordon, <i>Essex-lodge, Muswell-hill, N.</i>	1897*	Scott, Alexander Lewis, <i>Australian Mutual Provident Society, Melbourne.</i>
1896*	Robinson, Frederick Charles, <i>Royal Exchange Assur. Corporation, Royal Exchange, E.C.</i>	1900*	Searle, Arthur Joseph, <i>English & Scottish Law Life Assurance Association, Limited, 12 Waterloo-place, S.W.</i>
1898*	Robinson, Hugh Thomas Kay, <i>Clergy Mutual Assurance Society, 2 & 3 The Sanctuary, Westminster, S.W.</i>	1888	Sewell, Richard, C.A., F.F.A., <i>63 Threadneedle-street, E.C.</i>
1893*	Roll, Frederick James, <i>Pearl Life Assurance Company, London-bridge, E.C.</i>	1886*	Sharp, Joseph Benjamin, <i>Clerical, Medical and General Life Assurance Society, 15 St. James's-square, S.W.</i>
1893*	Roodenburch, Bartholomeus Adrianus, <i>Algemeene Maatschappij van Levensverzekering en Lijfrente, Damrak, 74, Amsterdam.</i>	1896	Shawyer, John William, <i>Law Union & Crown Insurance Co., 126 Chancery-lane, W.C.</i>
1895*	Ross, Christopher Watson, <i>c/o Messrs. M. Moss & Co., Flinder's-lane, Melbourne, Australia.</i>	1900*	Shovelton, Sydney Taverner, <i>532 Eccles New-road, Manchester.</i>
1901*	Rountree, Arthur FitzGerald, <i>The Vicarage, Werneth, Oldham.</i>	1896*	Slute, Oxenham Bent, <i>National Provincial Bank of England, 53 Baker-street, W.</i>
1895	Rowley, James Edward, A.C.A., <i>7 Waterloo-street, Birmingham.</i>	1895	Simmons, Lancelot, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1895*	Rudd, Alfred James, <i>Australian Widows' Fund Life Assurance Society, Melbourne, Australia.</i>	1892*	Simpson, William Murray, <i>North British and Mercantile Insurance Company, 61 Threadneedle-street, E.C.</i>
1899*	Rutter, Edward Valentine, <i>129 Tredegar-road, Bow, E.</i>	1891*	Sindall, Alfred John, <i>London and Lancashire Life Assurance Co., 66 & 67 Cornhill, E.C.</i>
1894	Salter, George Ferry, Mem. Act. Soe. Amer., <i>Prudential Insurance Company of America, Newark, N.J., U.S.A.</i>	1899*	Skelton, Reginald Albert, <i>"Sunnymead," Elstree, Herts.</i>
1894*	Saunders, Herbert Stewart, M.A., <i>3 Bolton-gardens, S.W.</i>	1888**	Slimon, William James, F.F.A., <i>2 James'-place, Leith.</i>
1892*	Savery, Robert S. B., <i>Gresham Life Assurance Society, Giselastrasse, No. 1, Vienna.</i>	1895*	Smeaton, John Richard, <i>Alliance Assurance Company, 61 New-street, Birmingham.</i>

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Date of becoming a Student.		Date of becoming a Student.	
1900*	Somerville, Walter Harold, <i>Mutual Life Assurance Company of Canada, Waterloo, Ontario, Canada.</i>	1895*	Thistlethwaite, William, <i>4 Warren-terrace, Wakefield.</i>
1901*	Spurgeon, Ernest Frank, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1900*	Thomson, Frederick Robert T., <i>11 Baalbeck-road, Highbury, N.</i>
1897*	Stamp, Horatio E., <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1897*	Thorne, Charles McKellar, <i>Temperance & General Life Assur. Co., cr. Swanston & Little Collins-street, Melbourne, Australia.</i>
1901*	Steffensen, Johan F., <i>"Nordisk" Re-insurance Co., 3 Romersgade, Copenhagen.</i>	1897*	Tipping, Oswald, <i>Trustees', Executors', and Agency Co., Limited, 412 Collins-street, Melbourne, Victoria, Australia.</i>
1898**	Stewart, Lionel William, <i>Alliance Assurance Company, Bartholomew-lane, E.C.</i>	1901*	Todhunter, Joseph, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>
1886**	Stirling, James, <i>Scottish Imperial Insurance Co., 183 West George-st., Glasgow.</i>	1897*	Touzel, Philip Duncan, <i>Australian Mutual Provident Society, Melbourne, Australia.</i>
1888*	Stott, Walter, <i>Royal Insurance Co., Liverpool.</i>	1897*	Townshend, Edward Villiers, <i>North British and Mercantile Insurance Co., 7 Tithebarn-street, Liverpool.</i>
1893*	Streeter, Theodore Edward, <i>Hampden House, Phoenix-street, King's-cross, N.W.</i>	1901*	Traversi, Antonio Thomas, <i>Government Life Insurance Dept., Wellington, New Zealand.</i>
1899*	Stuckey, Reginald Robert, <i>Australian Mutual Provident Society, Adelaide, S. Australia.</i>	1901*	Tregaskis, George, <i>Sun Fire Insurance Company, 63 Threadneedle-street, E.C.</i>
1901*	Sutcliffe, Charles Ernest, <i>Hand-in-Hand Insurance Co., Manchester.</i>	1897	Truzzell, Harry, <i>Northern Assurance Company, 15 Victoria-street, Nottingham.</i>
1895*	Sutton, Cecil Norman Stafford, <i>Marine & General Mutual Life Assurance Society, 14 Leadenhall-street, E.C.</i>	1891	Tyler, Edgar Alfred, F.S.S., <i>20 Bucklersbury, E.C.</i>
1901*	Tarr, Stambury R., <i>Canada Life Assurance Co., Toronto, Canada.</i>	1895*	Walker, David Edgar, <i>Australian Mutual Provident Society, Sydney, Australia.</i>
1895	Taylor, Leopold Victor, <i>Prudential Assurance Company, Holborn-bars, E.C.</i>	1900*	Wandless, John Robert, <i>Northumbria, Hockley, Essex.</i>
1901*	Taylor, L. W., <i>Collegiate Institute, Lindsay, Ontario, Canada.</i>		

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Date of becoming a Student.		Date of becoming a Student.	
1898	Ward, Albert E., <i>Australian Mutual Provident Society, Melbourne, Australia.</i>	1900	Williams, Lewis, B.A., <i>Hand-in-Hand Insurance Co., 26 New Bridge-street, E.C.</i>
1900*	Wares, Harold Wallace, <i>Yorkshire Insurance Company, 2, Bank-buildings, Princes-street, E.C.</i>	1899*	Williams, William, B.A., <i>Kerioi, Shadworth-st., Mosman, Sydney, Australia.</i>
1900*	Watt, Arthur W., <i>Sun Life Assur. Co. of Canada, Montreal, Canada.</i>	1901*	Wilton, Herbert George, <i>Norwich Union Life Office, Norwich.</i>
1899*	Weatherill, Charles, <i>The Scottish Office, Whitehall, S.W.</i>	1894*	Windett, Sydney V., <i>Eagle Insurance Company, 79 Pall-mall, S.W.</i>
1898*	Webb, Lloyd, <i>Hand-in-Hand Insurance Soc., 26 New Bridge-street, E.C.</i>	1899*	Winstanley, Charles William, <i>North British & Mercantile Insurance Co., 8 Waterloo-place, S.W.</i>
1893*	Welman, Arthur Joseph, <i>Legal & General Life Assurance Society, 10 Fleet-street, E.C.</i>	1895*	Wood, David James, <i>Commercial Union Assurance Co., 24, 25 & 26 Cornhill, E.C.</i>
1888	Westland, James Black, <i>Northern Assurance Company, 1 Moorgate-street, E.C.</i>	1901*	Wood, Roland Stuart, <i>Liverpool and London and Globe Insurance Co., 7 Cornhill, E.C.</i>
1896*	Wheatley, George Frederick Layfield, <i>Liverpool and London and Globe Insurance Company, 7 Cornhill, E.C.</i>	1900*	Wood, William Archibald Porter, <i>Canada Life Assurance Co., Toronto, Canada.</i>
1897*	Wigner, John Gurney, <i>92 Tyrwhitt-road, St. John's, S.E.</i>	1896*	Woodhouse, Hubert Allen, <i>Union Insurance Society, 81 Cornhill, E.C.</i>
1900*	Wilkinson, William Magnay, Jun., <i>Citizens' Life Assurance Co., Sydney, Australia.</i>	1900*	Woolston, Paul Livingston, B.S., <i>New York Life Insurance Co., 346 & 348 Broadway, New York.</i>
1886*	Williams, David, <i>181 Queen Victoria-street, E.C.</i>	1900*	Worth, Bertram Oliver, <i>Clerical, Medical & General Life Assurance Society, 15 St. James's-square, S.W.</i>
1894*	Williams, Frederick Alfred, <i>Hurstpierpoint, Hornchurch, Essex.</i>	1888**a	Worthington, William, <i>Lancashire Insurance Company, 18 Exchange-street, Manchester.</i>
1895*	Williams, Henry Samuel Walter, <i>The Imperial Insur. Co., Ltd., 410 Collins-street, Melbourne, Australia.</i>	1894*	Wyatt, George Matthew, <i>Law Guarantee & Trust Society, 49 Chancery-lane, W.C.</i>

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Date of
becoming
a Student.

1894* Wylie, Samuel Brown, A.M.,
112 N. Broad-st., Philadelphia,
U.S.A.

1886 Yeatman, Alexander Alfred,
2 Gresham-buildings, E.C.

Date of
becoming
a Student.

1895* Yeldham, William James,
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Holborn-bars, E.C.

1897* Younger, R. Hugh,
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26 New Bridge-street, E.C.

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*Ex-President of the Actuarial Society
 of America (1891-93); Consulting
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BROWN PRIZE ESSAY (1900).

THE

Actuarial Aspects of Recent Legislation,

IN THE

UNITED KINGDOM AND OTHER COUNTRIES,

ON THE SUBJECT OF

Compensation to Workmen for Accidents.

BY

JOHN NICOLL, F.F.A., A.I.A.,

Of the Life Association of Scotland.

Being the Essay to which the First and only Prize was awarded
from the Brown Prize Fund in the Year 1900.

ABSTRACT OF THE DISCUSSION

which took place at the Institute of Actuaries,
when the Essay was read.

[The Council of the Institute of Actuaries wish it to be understood, that while they consider it their duty to give, from time to time, publicity to certain of the papers presented to the Institute, they do not hold themselves responsible for the opinions put forward therein.]

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INSTITUTE OF ACTUARIES.

BROWN PRIZE ESSAY (1900).

The Actuarial Aspects of Recent Legislation, in the United Kingdom and other Countries, on the subject of Compensation to Workmen for Accidents. By JOHN NICOLL, F.F.A., A.I.A., of the Life Association of Scotland. Being the Essay to which the First and only Prize was awarded from the Brown Prize Fund in the Year 1900.

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1.—INTRODUCTORY.

Traces of
Employers'
Liability in
Early Days.

THE liability of the employer to compensate his employees, as well as other persons, for injuries sustained through his fault, may be traced from an early period in the world's history in the Common Law of various countries.

For example, by the Jewish Law, said to have been promulgated about the year 1500 B.C., if a master were the means of causing the loss, either intentionally or unintentionally, of the eye or of the tooth of his slave, he was bound to let him go free for his eye or his tooth's sake. Again, according to the same law, if an employer allowed his ox to gore either his servant or a stranger, he was required to pay various compensations to the injured if he survived, or to his relatives in the event of the injury being followed by death.

If we had time, and it were necessary to do so, we could show that there have been similar enactments in our own and other countries in former days, and that these have continued with little alteration to form part of the Common Law until comparatively a few years ago. It is, however, to be remarked that, in the matter of compensation for injuries occasioned by accidents, the Common Law favoured in some respects strangers more than workmen, and this was no doubt one reason for the introduction of special legislation on the subject. At the same time it must be admitted that there were other causes at work also in bringing about an alteration in the law, and we shall endeavour shortly to trace some of these now.

Early Relations of Employers and Employed. Before the beginning of the present century, when large steam factories were unknown, the status of employers and their relation to their workmen were very different from what they now are. Manufacturers were then, as a rule, in a small way. They worked themselves at their looms or at their trades, and they, generally speaking, employed only a very few other workmen, over whom they were able to exercise careful, as well as constant, personal supervision. The workmen were at first slaves, and, even as freemen, they continued for long to form part of the employer's household, boarding with him, sitting at the same table with him, and being generally on familiar and friendly terms with him. In such circumstances accidents were bound to be infrequent; and, when they did occur, they were looked at from an altogether different point of view from that from which they are regarded now-a-days. The injured workman of old, so long as he was incapacitated, would be cared for by the employer and his household, by whom he would be sympathetically nursed while he was laid up, and by whom also the medical and other expenses attendant on his cure would be willingly borne. On his recovery, gratitude for the kindness shown to him, together with the friendly feeling existing all along between the parties, would preclude the idea of raising a law suit to recover an indemnity for the injury.

Influences of Introduction of Steam. With the introduction of steam, however, not only were the methods of manufacture revolutionized and the liability to accidents affected thereby, but the relations of the employer and employed underwent at the same time an immediate and manifest change.

Whether the introduction of steam has increased the number of accidents, statistics alone could show. It is very unlikely,

however, that reliable figures on the point can be obtained in our own country at least. The *impression* would seem to be that accidents have increased under the new conditions. As regards France, however, a French writer states that "it is notable that accidents were, and are still, in proportion much more numerous in manual industries than in those which employ machinery; and that the care of horses for example is more dangerous than of machines." Further, that "it is the industries of building and terrace making which, in proportion, claim the most victims." In our own country, too, Dr. Farr noticed, as early as the year 1856, the great mortality due to horses and horse conveyances, and he reverts to the same subject in various subsequent Reports.

Changes in the Relations of Employers and Employed. As regards the change in the outward relations of the employer and his employed, increase of wealth has led the former to live and move now in an altogether different circle from the latter, and the number of the employees in any one concern often makes it quite impossible for the employer to know even the names of his workpeople, far less, as formerly, to take a personal interest in each of them. The conversion of private businesses into Limited Liability Companies, which has been of very frequent occurrence of late years, has without doubt tended to widen this gap still further.

In some countries this separation between the employers and employed has evidently led to a weakening of the realization of the identity of their several interests, and has caused the employer in some cases to regard his workpeople merely as part of his necessary machinery, to be used while they can be of service, and to be got rid of, as decently as possible, it may be, when they are no longer able to work. That feeling on the part of the masters, has, as was to be expected, reacted on the workmen, who in many cases have come to regard the employer simply as the source from which as much as possible in the way of wages is to be extracted for the least possible expenditure of strength and skill on their part. Hence might be traced the rise of Trades Unions and of Socialism.

Trades Unions and Socialism. The former, when they are properly conducted, as they seem, generally speaking, to be in our own country, are legitimate enough, and really serve many very useful ends. In other countries than our own, however, and in Germany very specially, Socialism has come to be a factor with which the State has had to reckon. A French advocate, M. Valleroux, affirms that the

three German Assurance laws against Sickness, Accidents, and Old Age, were introduced by Prince Bismarck into the German Parliament with the avowed object of counteracting the influence of Socialistic agitators. The same writer then goes on to prove that, instead of lessening the influence of the Socialists, the laws referred to have had the effect of extending their views, and of vastly increasing their power. That, whereas there were five Socialist Deputies in the Reichstag when the laws were introduced, the number of Socialist Deputies had risen in 1893 to forty-five, and at the last elections in 1898 to fifty-six. The inference drawn from this is that the people have been inclined to give the Socialists the entire credit for any advantages they may have derived from recent legislation.

Compulsory State Insurance in Germany. On the subject of Compulsory State Insurance in Germany, Mr. W. F. Willoughby, of the U.S. Department of Labour, writes as follows:—"The present system of Compulsory State Insurance, often termed the boldest experiment in social legislation ever attempted, had its impelling causes in three distinct circumstances; that of the development of a political philosophy which accorded to the State the widest attributes for the purpose of improving social conditions; that of the rapid rise of a social democracy, which, impatient at the feeble improvement accomplished under the existing organization of society, avowedly sought a complete destruction of the existing social fabric in order to introduce a new *régime*; and that of the beneficial results already accomplished through partly voluntary and partly compulsory insurance societies."

Present Relations of Employers and Employed. It is unnecessary, perhaps, for us to follow out further this line of enquiry. As regards our own land, there seem grounds for believing that a very good feeling still exists generally between employers and employed. There not now, it is true, the same intimacy as in old days between the parties, but there is no doubt that there is still not a little real kindly interest on the part of employers in their employees, who in return evince a friendly and appreciative regard for those they serve. Numerous instances of benefactions on the part of private firms and of companies might be cited in support of these statements. What should be much more convincing and satisfactory, however, is the official confirmation of the opinion we have expressed, and which is to be found in the Report of the Chief Registrar of Friendly Societies for the year ending

31 December 1898. Dealing with the result of his experience in regard to the terms of various schemes submitted to him in connection with the Contracting-out Section of the 1897 Aet, the Registrar proceeds to say:—"In most cases amendments " have readily been made, and it may be said, without hesitation, " that the result of the first six months' working of the " Contracting-out Section has been to show, on the part of the " employers who have applied for Certificates to schemes, a desire " to meet their workmen in the most handsome manner, and on " the part of the workmen an excellent feeling of fairness and " goodwill." That there have been so many as 62 schemes certified by the Registrar between the coming into force of the new Aet in July 1898 and 31 December 1898, shows that, independently of legislation, there has already existed a great amount of spontaneous interest in, and anxiety for, the welfare of the workmen in this country on the part of their employers. In fact, in place of legislation as to Liability for Accidents imposing a further burden on the employers of labour, it may well be found that, in very many cases, their expenditure on this head is really less under the Act than it was when they were prompted in great measure merely by their own humane and generous impulses.

It would no doubt prove a most interesting and instructive enquiry to follow out fully the causes, social, industrial, and political, which have led to much of the legislation generally in recent years, and in regard to Employers' Liability for Accidents in particular, but we must content ourselves for the present with the few hints and suggestions we have already thrown out on the subject.

Probable Course of Future Legislation. As regards the *future*, there is every reason to expect that legislation will not rest merely at Compulsory Compensation for Accidents. If the workman is to be relieved in case of illness through injury, why should he not also be provided for when laid aside by sickness of every form? Further, seeing that employers are already liable for compensation in case of accidents, it is but natural to expect that they will try to safeguard themselves as far as possible, and one form in which they are likely to do so is by dispensing with the services of workmen who are getting up in years, and who may be likely, through failing health and strength, to bring accidents upon themselves or upon others. These aged workmen will have to be provided for in some way or another, and it

follows that, as a further result of Compulsory Liability for Accidents, a measure will very soon have to be introduced providing for superannuation in old age. This same point was brought out prominently at a recent meeting at Cardiff of the Executive of the National Committee of Organized Labour, when reference was made to the "gratifying signs of progress which" have been made on the Old Age Pensions question during the "last 12 months." It was stated that the change, in the judgment of the Executive, is to be attributed in great measure to the Workmen's Compensation Act, which has brought about, or threatens to bring about, the much earlier superannuation of large numbers of workmen. It would seem, therefore, that actuaries would do well to prepare themselves even now for dealing in the near future with, in addition to assurance against accidents, extended and national schemes of assurance against sickness and old age.

We shall now proceed to deal with another branch of our enquiry, namely, "The Provisions of Various Laws."

II.—THE PROVISIONS OF THE VARIOUS LAWS ON THE SUBJECT OF COMPENSATION TO WORKMEN FOR ACCIDENTS IN OUR OWN AND OTHER COUNTRIES.

(1).—*Great Britain.*

**Courses of
Action open to
Employees
against their
Employers.**

As the law at present stands in this country, a workman injured by accident in the course of his employment may, in certain circumstances, proceed against his employer for compensation in one of the three following ways, namely, under (a) The Common Law; or (b) The Employers' Liability Act, 1880; or (c) The Workmen's Compensation Act, 1897. One condition only is laid down, and that is that, in deciding to proceed under one or other of these Laws, the injured workman must not make a claim under any other form.

We shall accordingly consider shortly each of the three foregoing divisions of the Law. And first of all, we shall deal with

(a) *The Common Law.*

The essential principle of the Common Law, as regards injuries, is that only the person who actually does the damage is

liable for it. When, however, anyone employs another to do something for him, the employer, except in the case to be immediately noticed, is responsible for the acts of the person employed by him. The exceptional case to which we refer is comprehended under the doctrine of "Common Employment," which frees the employer from liability in the event of the injury being caused through the negligence of a fellow workman. It is assumed under that doctrine that when a workman engaged himself in any trade he was quite aware of the fact that accidents might occur at times through the negligence of his fellow workmen, however skilful and careful they might be as a rule. The Courts, therefore, held that, in entering the service of the employer, the workman had agreed as one of the terms of his contract, to be himself liable to such risks. It is worth mentioning, perhaps, that the doctrine of "Common Employment" did not apply in Scotland until the year 1858, when the law in that respect was assimilated to the law of England. Previously to that year, an employer was liable to a workman for an injury sustained by him, even through the negligence of a fellow workman.

Until the year 1846, the law of England gave the representatives of a workman who *died* from the result of injuries received in his employment no right of action against the employer, though in Scotland the representatives had the right to recover damages. In that year the measure which is known as Lord Campbell's Act was passed, giving the *executor* of the deceased the right, within twelve months after the death of the injured, to maintain an action and recover damages. In 1864, a short Act was passed amending Lord Campbell's Act in respect that, if the executor of the deceased neglected, within six months after the death, to raise an action, then the beneficiaries, or any one of them, might raise the action in their own name.

Circumstances under which right to raise Action may still be lost. There seems to be one other case still existing in England in which the right to raise an action may be lost, namely, where the employer—if sole and not the member of a co-partnery or Company—dies before the action is initiated. In that instance, the right of action in England would apparently fall, but in Scotland the parties may proceed against the estate of the deceased employer for damages.

Definite legislation as to employers' liability for injuries to

workmen proceeded very cautiously in this country. As early as the year 1872, a Bill seems to have been introduced into Parliament providing for compensation to workmen in cases of injury or death, and almost every year thereafter, until the year 1880, measures dealing in one way or another with the same subject, and in nearly every case providing for the abolition of the defence of common employment, appear to have been brought forward. All of these attempts at legislation were, however, either withdrawn or indefinitely postponed.

In the year 1880, however, after being several times re-committed and amended in Committee, there was produced

(b) *The Employers' Liability Act, 1880.*

This Act came into operation on 1 January 1881, and was to continue in force only until 31 December 1887, and to the end of the then Session of Parliament, unless Parliament should otherwise determine. It has been kept continuously in force since the latter date by being included in the "Expiring Laws Continuance Acts."

It is applicable, under the general term of "Workmen", to railway servants, labourers, servants in husbandry, journeymen, artificers, handicraftsmen, miners, and others engaged in manual labour. It does not apply to domestic or menial servants.

It gives the workman the same right of compensation and remedies against the employer as a stranger has, when personal injury is caused to him—

- | | |
|--|--|
| <p>Circumstances under which Compensation may be claimed.</p> | <p>(1) By reason of any defect in the machinery, &c., used in the business, where such defect had not been discovered or remedied owing to the negligence of the employer or of someone entrusted by him with looking after machinery, &c.</p> <p>(2) „ „ the negligence of any superintendent in the service of the employer.</p> <p>(3) „ „ the negligence of any person in the service of the employer to whose order the workman was bound to conform and did conform.</p> |
|--|--|

- (4) By reason of the act or omission of any person in the service of the employer in obedience to the rules or bye-laws of the employer, but only when the injury was due to some impropriety or defect in such rules or bye-laws.
- (5) „ „ the negligence of any person in the service of the employer who has charge or control of any signal, points, locomotive engine, or train upon a railway.

When Compensation may not be claimed. A workman is not entitled to compensation under this Act if he knew of the defect or negligence which caused his injury and failed, within a reasonable time, to give information thereof to his superior, unless he was aware that the superior already knew of the defect or negligence.

Amount of Compensation. The compensation provided for under the Act is limited to a sum equivalent to the estimated earnings, during the three years preceding injury, of a person in the same grade employed during those years in the like employment, and in the district in which the workman is employed at the time of the injury.

Notice. Notice in respect of an injury must give the name and address of the person injured, and state in ordinary language the cause of the injury and the date at which it was sustained, and it may be delivered at the residence or place of business of the person on whom it is to be served, or may be sent by registered letter. Such notice must be given within six weeks, and any action must be commenced within six months of the occurrence of the accident; or, in the case of death, within twelve months from the time of death, unless in the opinion of the judge there was reasonable excuse for the want of such notice. Any defect or inaccuracy in the notice shall not, however, make it invalid, unless the judge is of opinion that it was for purposes of misleading and that the defendant is prejudiced thereby.

Every action for recovery of compensation must be brought in a County Court (or the equivalent Courts in Scotland or Ireland), but may be removed into a superior court on application by either side. The action may be before a jury, or simply before the judge with assessors.

We do not intend to enter here into criticisms of the various

Laws the scope of which we have to explain, but it may be remarked that, as the Employers' Liability Act, 1880, was passed for a fixed period merely, with evident misgivings, and chiefly to mitigate the hardships of the doctrine of "Common Employment", which, however, it only dealt with partially, it was to be expected that it should be looked upon from the first pretty much as a tentative measure to be modified or extended as experience should suggest and warrant.

Bill of 1893.

Accordingly, in 1893, a further Bill was introduced into Parliament by Mr. Asquith, based upon the recommendations of a Select Committee of the House of Commons. This Bill was, however, abandoned because the House of Lords insisted on a clause being embodied in it dealing with and permitting "contracting out." It may be well to explain here that by the term "contracting out" is meant that the workman enters into an agreement with the employer to give up his rights under the Act, and to substitute for its provisions the benefits of some private scheme, which usually gives compensation for all injuries incidental to the employment, whether provided for under the Act or not.

The abandonment of the Bill of 1893 only delayed the course of legislation for a very short time. The matter was again taken actively in hand, this time by Mr. Chamberlain, with the result that in the end there was passed the latest measure dealing with the subject, namely,

(c). *The Workmen's Compensation Act, 1897.*

**Application
of 1897 Act.**

This Act came into operation on 1 July 1898. It applies to employment on or in or about a Railway, Factory, Mine, Quarry or Engineering work, and to employment on in or about any building which exceeds thirty feet in height, and is either being constructed or repaired by means of a scaffolding, or being demolished, or on which machinery driven by steam, water, or other mechanical power is being used for the purpose of the construction, repair, or demolition thereof. (The limitation of the height of the building to thirty feet was supposed to have been inserted for the purpose of excluding work upon agricultural buildings which are usually under that height, but the Home Secretary mentioned in Parliament lately that the thirty feet limit was taken merely for purposes of convenience from the Factories Act.)

The Act, it will be seen, covers most of the important

employments, but it does not apply to Domestic Servants, Seamen, Farm Labourers, or Workshop employees.

First 2 Weeks of Incapacity excluded. The employer is not liable in respect of any accident which does not prevent the workman for a period of at least two weeks from earning full wages.

Case where Compensation disallowed. Compensation shall be disallowed when it is proved that the injury was due to the serious and wilful misconduct of the workman.

Alternative Course of Action. When the injury arose through the personal negligence or wilful act of the employer, or of some person for whom the employer is responsible, the workman may at his option either claim compensation under this Act, or take the same proceedings as were open to him before the commencement of this Act. The employer is not, however, liable to pay compensation both independently of, and also under, this Act.

Settlement of Disputes. Disputes as to liability to pay compensation under this Act, if not settled by agreement, are to be settled by arbitration in accordance with the second schedule to this Act.

Actions improperly raised. If an action is raised independently of this Act, and it is determined that it should have been raised under this Act, the action shall be dismissed; but the Court in which the action is tried shall, if the plaintiff choose, proceed to assess compensation, and may deduct from compensation all costs which have been caused by the action being brought under the wrong Act.

1897 Act. Mines and Factories Fines. Nothing in the Act shall affect any proceeding for a fine under the enactments relating to mines or factories or the application of any such fine. If any part of such fine has been applied for the benefit of an injured workman, the amount so applied may be taken account of in estimating the compensation under this Act.

Notice. Notice of the accident must be given as soon as practicable after the happening thereof, and before the workman has voluntarily left the employment in which he was injured.

Lodging of Claim for Compensation. Claims for compensation must be lodged within *six* months of date of accident; or, in case of death, within six months from date of death.

Action not barred from want of Notice. If, however, it is found that the employer is not prejudiced in his defence by the want, defect, or inaccuracy of notice, the maintenance of proceedings shall not be barred in consequence of such want, defect, &c.

**Serving of
Notice.**

The regulations as to serving notice of injury are the same as under the 1880 Act, namely :—

Notice must give name and address of person injured, and state in ordinary language the cause of the injury and the date at which it was sustained.

The notice may be delivered at the residence or office of the employer, or may be sent by registered letter.

If the employer is a body of persons having more than one office, notice may be delivered, or posted by registered letter, to any of the offices.

**“ Contracting
Out.”**

If the Registrar of Friendly Societies, after ascertaining the views of the employer and workmen, certifies that any scheme of compensation, benefit, or insurance for the workmen of an employer is, on the whole, not less favourable to the general body of workmen and their dependants than the provisions of this Act, the employer may contract with any of those workmen that the provisions of the scheme shall be substituted for the provisions of this Act, and thereupon the employer shall be liable only in accordance with the scheme. In all other cases the Act shall apply notwithstanding any contract to the contrary made after the commencement of this Act. The Registrar may give a certificate to expire at the end of a limited period not less than five years. No scheme shall be so certified which requires the workmen to join as a condition of their hiring.

**Revoking of
Certificate by
Registrar.**

If complaint is made to the Registrar of Friendly Societies by the workmen of any employer that satisfactory reasons exist for revoking the certificate, the Registrar shall examine into the complaint, and, if satisfied that good cause exists for such complaint, shall, unless the cause of complaint is removed, revoke the certificate.

When a certificate is revoked any moneys held for the purpose of the scheme shall be distributed as the employer and workmen shall arrange, or, in the event of a difference of opinion, as determined by the Registrar of Friendly Societies.

When a scheme is certified the employer must furnish all accounts, and answer any enquiries made by the Registrar of Friendly Societies.

The Chief Registrar of Friendly Societies shall include in his Annual Report particulars of the proceedings of the Registrar under this Act.

Workmen of Sub-Contractors. Employers are liable to pay compensation to workmen of sub-contractors subject to being entitled to be indemnified by any other person who would have been liable independently of this section of the Act, but this does not apply to any work which is merely ancillary or incidental to the principal business.

Bankruptcy of Employer who is Insured. In the event of an employer who has been found liable for compensation for an injury becoming bankrupt, and being entitled to be indemnified by an Insurance Company, the workman shall have a first charge upon the indemnity.

Courses of Action when Liability is entailed on others than Employer. When the injury for which compensation is payable under this Act entails legal liability in some person other than the employer, the workman may proceed to recover damages either against that person or against the employer, but not against both. If compensation be paid by the employer he shall be entitled to be indemnified by the other person.

Act not to apply to Naval and Military Services. This Act shall not apply to persons in the Naval and Military Service of the Crown, but otherwise it shall apply to any employment under the Crown to which this Act would apply if the employer were a private person.

Treasury may frame Scheme of Contracting Out for Civil Service. The Treasury may frame a scheme of contracting out for the Civil Service to be submitted to the Registrar of Friendly Societies.

Schemes of Contracting Out existing previous to Act. Any contract existing previous to this Act whereby a workman relinquishes his right to compensation for injury shall not be deemed to continue after the time at which the workman's contract of service would determine if notice of the determination thereof were given at the commencement of this Act.

The compensation allowed by the first Schedule of the Act is as follows :—

(a) Where death results from the injury—

Compensation.

- (1) If the workman leaves any dependants wholly dependent upon his earnings, a sum equal to three years' wages, or £150, whichever amount is larger, but not exceeding £300 in any case. Any weekly payments made under the Act to be deducted from such sum.

- (2) If dependants in part only dependent, such sum as may be agreed on or determined by arbitration to be reasonable and proportionate to the injury, but not exceeding the sums in (1).
- (3) If there are no dependants, expenses of medical attendance and burial not exceeding £10.
- (b) In case of total or partial incapacity for work, a weekly payment during incapacity, *after the second week*, not exceeding 50 per-cent of the average weekly earnings, but not exceeding £1.

In fixing the weekly payment, regard shall be had to the difference between the average wage before the accident, and that earnable after the accident, and to any payment, not being wages, received from the employer during incapacity.

Injured must submit to Medical Examination. When a workman gives notice of an accident, he must, if required, submit himself for examination by a medical man provided and paid for by the employer. If he refuses, any proceedings under this Act in relation to compensation shall be suspended until such examination takes place.

In case of death, payments shall be made to the legal personal representative of the workman for the benefit of his dependants.

Questions as to Dependants. Any question as to who is a dependant, or as to the amount payable to each dependant shall, in default of agreement, be settled by arbitration under this Act.

Investment of Compensation. Various regulations are laid down providing, where it is agreed or ordered by the Committee or other Arbitrator, for the deposit in whole or in part of compensation in the Savings Bank, or for its investment in an annuity.

Injured must submit to Medical Examination from time to time. A workman receiving a weekly allowance must submit himself as required, from time to time, for medical examination by an examiner provided and paid for by the employer. If the workman objects to be examined by the employer's doctor, or is dissatisfied with his report, he may submit himself to one of the medical examiners appointed under this Act, and the certificate of such examiner shall be conclusive evidence as to the workman's condition. If the

workman refuses to submit to examination, the weekly payments shall be suspended till the examination has taken place.

Weekly Payments may be reviewed.

Any weekly payment may be reviewed at the request either of the employer or of the workman, and may be ended, diminished, or increased, subject to the maximum before provided. In default of agreement, the amount of the payment shall be settled by arbitration under the Act.

Employer may commute Weekly Payments after Six Months.

Where a weekly payment has been continued for not less than six months, the employer may redeem the future payments by a lump sum to be settled, in default of agreement, by arbitration under this Act, and such lump sum may be ordered by the Committee or Arbitrator to be invested or otherwise applied as above mentioned.

Compensation not assignable nor attachable.

A weekly payment, or a sum paid in redemption thereof, shall not be capable of being assigned, charged or attached.

Powers of Friendly Societies extended for Purposes of this Act.

For the purposes of this Act, Friendly Societies undertaking payment of compensation are relieved from certain restrictions of the Friendly Societies' Act, 1896, so far as regards schemes under this Act.

Second Schedule of Act.

The second Schedule of the Act deals with various regulations as to arbitration, either by a Committee representative of the employer and his workmen, if such exists, or by a single Arbitrator; with various County Court rules; and for the appointment of medical examiners for the purposes of the Act.

Differences between Common Law, 1880 Act, and 1897 Act.

Such are the chief provisions of the Workmen's Compensation Act, 1897. It will be seen that, while, under the Common Law, the employer was liable only for *personal* negligence, his liability was successively extended, under the 1880 Act, to his foreman, and, under the 1897 Act, to every man in his service. As the law now stands, it is immaterial what was the cause of an accident, provided it was not due to the serious and wilful misconduct of the workman. The fact that he has been injured by an accident in the course of his employment entitles him to compensation, irrespectively of whether the fault which led to the accident was the master's, the foreman's, a fellow workman's, or his own.

Probable Causes of Litigation.

There are one or two of the provisions of the Act that are, according to general opinion, likely to lead to a considerable amount of litigation, especially the

clause enacting that compensation shall be disallowed when it is proved that the injury was due to the serious and wilful misconduct of the workman.

Anomalies in fixing Compensation. Then the fixing of the compensation in case of partial incapacity is apparently to lead to anomalous results, as the following instances which have been brought forward will show. Two men had each a leg broken by accident, and one of them, in Cardiff, received £75 compensation; while the other, in Nottingham, received only £25. Again, a labourer received £125 for a crushed hand at Manchester; while a boy, at Leeds, for the loss of a thumb and finger, was awarded £78; and a joiner at Leeds, for the loss of his entire arm, received only £58. Other examples might be given showing that, as a rule, compensation for injuries depends, in this country at least, pretty much upon the caprice of juries in various districts. We shall see later on that, in Italy, an effort has been made to draw up a pretty complete scale of the proportions in which the wages of the injured may be held to be reduced in cases of permanent partial invalidity by various classes of injuries. In Germany, also, to some extent, a similar effort has been made to assess the value of various injuries, and there does not seem any good reason why similar assessments should not be made in our own country for the chief injuries, at least, say, for the loss of a hand, of an arm, of a foot, of a leg, or of an eye.

Definitions of Incapacity in Accident Insurance Policies. The Accident Insurance Offices in this country have already defined, to some extent, the nature of the various degrees of incapacity. From a paper, read before the Actuarial Society of Edinburgh, by Mr. A. Gibbon Thomson, it appears that, in connection with ordinary accident policies, *death by accident* is defined as injury which shall be the sole and immediate cause of the assured's death within *three* calendar months from the date of the accident. (Under the Mines Regulation Act, an inquest is required if the injured dies within *twelve* months from the date of the accident.)

In some policies *temporary total disablement* is described as inability from accident which, in the opinion of a medical officer of the Company, necessarily confines to the house and renders the assured unable to attend in any degree to his business; while *temporary partial disablement* has been described as disablement by accident which, in the opinion of a medical officer of the Company, renders the assured unfit for some portion of his ordinary business.

Permanent total disablement is defined as the loss through accident, by physical separation above the ankle or wrist, of either both legs or both arms, or one leg and one arm, or the total and irrecoverable loss of the sight of both eyes.

Permanent partial disablement is defined as the loss through accident, by physical separation, of one leg or one arm, or the total and irrecoverable loss of the sight of one eye.

Workmen only may ask Registrar to revoke Certificate. In cases where there has been contracting out under the Act, it is apparently only the workmen who may suggest to the Registrar of Friendly Societies that satisfactory reasons exist for revoking the certificate of a scheme. The employer has, it would seem, no such privilege, but must be held bound to the scheme so long as the workmen are satisfied with it.

Extension of 1897 Act. There is no doubt that from the first this Act was never expected to be a final measure, and still further and extended legislation is likely to be required before very long. Already (March 1900) an Extension Bill bringing agricultural labourers under the benefits of the Act has been introduced into Parliament, and from the unanimity with which its provisions have been approved, it is certain that it will very soon pass into law. In supporting the Extension Bill on behalf of the Government, Sir M. White Ridley remarked that "unquestionably there would be before long a case for the revision of the "1897 Act, but the time was scarcely ripe yet for introducing "an amending Bill." The extension of the Act to seamen is also already foreshadowed.

Ground covered by 1897 Act. It is estimated that, even already, the 1897 Act deals with between 60 and 70 per-cent of all the accidents which occur in this country.

We shall now proceed to deal with the provisions of the laws as to compensation for trade accidents in various foreign countries. The German law on the subject is, perhaps, the first in point of time, and it is also the most important, seeing that it has formed the model of similar laws that have been passed subsequently in other foreign countries. We shall, however, leave the group of which the German law forms the centre until we have examined another law, which is of much more recent date, but which differs materially from all the others, namely, that of

2.—*France.*

Early
Legislation
in France.

Until April 1898, all questions having reference to compensation for trade accidents were regulated in France by three Articles of the Common Law, which read as follows, namely :—

Article 1382.—Any action whatever of a man which causes an injury to another obliges the person by whose fault the injury has occurred to repair it.

Article 1383.—Everybody is responsible for the injury he has caused, not only by his action, but also by his negligence and imprudence.

Article 1384.—A man is responsible not only for the injury he causes by his own action, but also for that which is caused by the action of persons for whom he is answerable, or of things in his charge.

This Common Law had been in operation for nearly a century, and had been largely made use of. On the whole, it had worked satisfactorily, though there were serious drawbacks and delays as regards the mode of procedure under it.

Special
Legislation
as to Trade
Accidents.

The first special legislation on the subject of employers' liability for trade accidents was brought forward in November 1881, and almost every year thereafter various projects of law were continued to be submitted to the Chamber of Deputies and to the Senate.

None of the Bills introduced during these years, however, succeeded in becoming law, and it was only on 9 April 1898 that the first special law dealing with the matter was finally passed, the provisions of which we shall now examine.

Application of
Law of 1898.

The Law of 9 April 1898 is applicable to workmen and clerks in factories, in the building trade, mines and quarries, warehouses, the carrying trade, and, in general, in all trades wherein mechanical engines are used.

First four
Days'
Invalidity
excluded.

No compensation is payable for any accident which does not lay the injured workman aside from work for more than *four* days.

Circumstances
under which
Compensation
may be
diminished or
increased.

The law does not permit any diminution of the compensation provided for, except in the event of an inexcusable fault being committed by the victim. It gives no compensation *only* in the case of an intentional fault. Should an accident be due to the inexcusable fault of the *employer*, compensation may be increased, and the

annuity payable to the victim may, in such case, be augmented up to the full amount of his annual wages.

Amounts of
Compensation
payable.

The following are the compensations allowed under the Act, namely :—

1. To the injured worker—

- (a) In case of *total* and *permanent* disablement, allowance equal to two-thirds of the annual wages.
- (b) In case of *partial permanent* disablement, an allowance equal to *one-half* of the *reduction* in wages caused by the accident.
- (c) In case of *temporary* disablement, a daily indemnity of one-half of the wages earned at the time of the accident, provided incapacity to work lasts more than four days, and to begin from the fifth day.

2. To the dependants of the worker, if death results from the accident—

- (a) To the widow or widower, if not divorced or living separate, 20 per-cent of the annual wages, provided the marriage was contracted before the accident occurred. In the case of a recent marriage, three years' wages are allowed.
- (b) To the children, legitimate or natural, acknowledged before the accident, orphans of father or of mother, and aged under 16 years, an allowance of 15 per-cent of the wages, if there is only *one* child; 25 per-cent if there are *two* children; 35 per-cent if there are *three* children; and 40 per-cent if there are *four* or *more* children.

For children, orphans of father and of mother, the allowance is extended for each of them to 20 per-cent of the wages.

The total of these allowances must not, in the first case, exceed 40 per-cent of the wages, or 60 per-cent in the second case.

- (c) If the victim has no wife or child in terms of paragraphs (a) and (b), each of the ascendants or descendants who were dependent on him shall receive an allowance, payable, in the case

of the ascendants, for life, and, in the case of the descendants, till age 16. That allowance will be equal to 10 per-cent of the wages of the victim, but the total of such allowances must not exceed 30 per-cent.

The allowances are payable quarterly; and they are unalienable and unseizable.

The employer has also to defray medical and funeral expenses, the latter not to exceed 100 francs.

Compensation to Aliens. Aliens injured, and who cease to reside on French territory, receive, as a total indemnity, three times the annual allowance that would have been paid to them.

The representatives of an alien workman do not receive any indemnity if, at the time of the accident, they were not resident on French territory.

Right to recover Damages against others than Employer. Independently of the action resulting from the present law, the injured or his representatives preserve, against the authors of the accident, other than the master, or his overseers or workmen, the right to recover reparation for the injury caused, in conformity to the laws of common right.

Wage Bases of Compensation. The wage to be taken as the basis for fixing allowances for workmen employed for a twelvemonth before the accident, is the amount earned by the workman in the twelve-months preceding the accident, whether it be in money or in kind.

For workmen employed during less than twelve months before the accident, the amount will be the effective remuneration which they have received since their entry into the employment, increased by the mean remuneration which workmen of the same category have received during the period required to complete the twelve months.

If the yearly wages of the workman injured exceed £96, he is to be entitled under the law to full compensation in respect of his earnings up to £96 only, every £1 of earnings over £96 counting, for the purpose of reckoning his claim for compensation, as five shillings only.

For workers aged less than 16, and for apprentices, the wage is to be taken as not less than that of the lowest workers of the same category in the same trade. At the same time, in case of temporary disablement, the indemnity of the worker aged less than 16 must not exceed the amount of his wage.

Intimation of Accidents. Every accident, occasioning incapacity from work, must be intimated, within 48 hours, by the employer or his overseers, to the Mayor of the Commune, who draws up the process-verbal of it.

Failure to give notice of an accident is punished with a fine of from 1 to 15 francs, and, in case of committing the same offence within a year, the fine may be increased from 16 to 300 francs.

Prescription of Action. The action for an indemnity is prescribed by the expiry of a year from the date of the day of the accident.

Revision of Indemnity. Revision of the indemnity, founded on an aggravation or an extenuation of the infirmity of the victim, or his death as a result of the consequences of the accident, is open for three years from the date of the agreement between the parties, or of the final decision of the Court.

Free Judicial Assistance. The benefit of judicial assistance is accorded free of charge to the victim of the accident.

Capitalization of Part of Indemnity. At the time of the final order for the life annuity, after the expiry of the three years for revision referred to above, the injured can require that the quarter, at the most, of the capital required to set up his allowance, calculated by the tables prepared for the injured by accidents by the National Old Age Pension Fund, may be paid to him in money.

He can also require that that capital, or that capital reduced by a quarter at most, as may be arranged, be applied as an annuity on his life continuable for a half at most on the life of his wife. In that case, the life annuity will be diminished in such manner as that the continuation will not result in any increase of the charges on the employer.

Whole Capital Value of Indemnity cannot be required from Employer. The payment of the capital representative of the pensions allowed by the present law cannot be required from the debtors (except as regards the one-fourth at most of the capital referred to above).

Employers may capitalize. Nevertheless, the debtors who desire to free themselves at once, can pay the capital representative of these pensions to the National Old Age Pension Fund, which will prepare, for that purpose, a table taking account of the mortality of the victims of accidents, and of their representatives.

Except in the case of that to the widow, a pension cannot be compensated by the payment of a capital sum which is not more than 100 francs.

Employer must capitalize Indemnities when he ceases his Work. When an employer ceases his work, be it voluntarily, by liquidation or otherwise, the capital representative of the pensions payable by him becomes exigible by right, and will be payable to the National Old Age Pension Fund. That capital will be determined at the day of its exigibility in accordance with the table referred to in the last paragraph. The employer may, however, be relieved of payment of that capital if he furnishes the guarantees required by the regulation of the public administration.

Agreements contrary to this Law are null. Every agreement contrary to the present law is null.

French National Assurance Funds. A National Fund for Assurance against Accidents was founded by the law of 11 July 1868, and was authorized, by the law of 24 May 1899, to extend its operations to the risks provided against by the law of 9 April 1898. There are also two other National Institutions, namely, the National Old Age Pension Fund, established by law of 18 June 1850; and the National Fund for Assurance against Death, founded at the same time as the Accident Assurance Fund, namely, 11 July 1868. All of these State Institutions are, however, purely voluntary in their operation.

Assurance against Accidents not compulsory. Assurance against accidents is not accordingly compulsory. So long as employers meet their liabilities, the law does not interfere. As already stated, it does not even insist on employers paying up the capital value of annuities. It is sufficient if they meet the payments as they fall due.

State Guarantee of Indemnities. In the absence of compulsory assurance, the payment of the compensation for indemnities for permanent incapacity for work, or for accidents followed by death, is nevertheless guaranteed by the State in the following manner :—

A special Guarantee Fund is formed by the addition of four centimes to the license taxes borne by all the trades which come under the law. (These extra centimes produce about 750,000 francs annually.) The extra tax may, however, be increased or reduced, as needs may require. The Fund so formed is managed by the National Old Age Pension Fund. In case of the bankruptcy of debtor employers, the National Fund intervenes, and pays the annuities to those interested, and withdraws the corresponding amounts from the Guarantee Fund. It then proceeds directly against the debtor for recovery of its

disbursements. When an employer is insured, and the Insurance Company fails, the National Fund will, in this instance also, pay the annuities, and proceed against the insolvent Insurance Company. The fact of being insured frees the employer from further liability, and, on this account, the law provided for Assurance Companies being put under stringent Government supervision, which compels them, among other things, to set up reserves. The character of the State control, and also the conditions under which the reserves are to be formed, will be referred to further on.

Law must be posted in Workshops.

The employers are bound, under pain of a fine of from 1 to 15 francs, to have the present law, and the rules of administration relative to its execution, posted up in each workshop. In case of a repetition of the omission to post the law in the same year, the fine will be from 16 to 100 francs.

Remarks on French Law.

Before passing from the French law, we may remark very shortly upon one of its provisions specially, namely, the Special Guarantee Fund which has been formed by Government for the payment of indemnities for permanent incapacity and death. The extra tax imposed upon industry on account of this Guarantee Fund seems, happily, in the meantime, a very small one, though, of course, in terms of the Act, there is no limit to the sum that may be levied for the requirements of the Fund in any year hereafter. It would seem to us to be entirely wrong in principle to levy such a tax against insolvency on employers generally. It is bound to have the effect, on the one hand, of increasing the difficulties of those employers who are honourably anxious to fulfil their obligations, and, on the other hand, of encouraging to further carelessness those who are already indifferent in regard to meeting their liabilities. Further, the relieving of the employer who assures from liability in case the Assurance Company fails, can only have one effect, namely, to make him only anxious to obtain the very cheapest rate of premium, and to be altogether careless as to the position of the Company he effects his assurance with.

Why the workman requires in all cases to be guaranteed his indemnity by the State is not quite clear. If he seeks employment with a firm that is not of good financial standing, it would seem only reasonable that he should be required to take the risk of loss in connection with his indemnity, as he will have to do in regard to his wages and other matters. We shall learn,

with interest, as time goes on, how this Guarantee Fund is found to fulfil its purpose.

It is perhaps worth while calling special attention to the fact that the French law is evidently suspicious as regards *partial* permanent disablement, as the indemnity allowed by it in these circumstances is limited to one half of the *reduction* in wages caused by the accident.

We shall now take up the group of laws to which we have already referred, and of which the first in point of time, as well as in importance, is that of

3.—*Germany.*

Early
Condition
of German
Law.

Previously to the year 1871, actions for compensation for injuries caused by accidents were brought in Germany under the Civil Law.

First Special
Law of 1871.

The first special law on the subject ("Haftpflichtgesetz") was promulgated on 7 June 1871. This law was passed, not only for the benefit of workmen, but for the benefit of all persons injured by the working of railways, mines, quarries, and manufactories.

Any person injured on a railway, or in the railway service, was entitled to a compensation from the railway direction, unless the said railway direction could prove satisfactorily that the accident had been caused by circumstances over which it, as an employer of labour, could have no control, or by the fault of the injured person himself. Further, by this law, any person injured by the working of a mine, quarry, or manufactory, was entitled to compensation from the owner of such mine, &c., provided the person injured could prove that the injury had been caused by the negligence of the owner or of a functionary in a position of authority in the owner's service.

The law of 1871 has never been formally abrogated, but it has practically been superseded, as far as workmen are concerned,

Accident and
Sickness Bills
originally
combined.

by the now well-known *Accident Insurance Law* ("Unfallversicherungs-Gesetz") of 1884. As Mr. T. E. Young has shown in his memorable paper on "The German Law of Insurance against Invalidity and Old Age", the Accident Insurance Bill and the Sickness Insurance Bill were originally introduced, in 1882, by the German Government as a combined measure. The Sickness Insurance portion of the conjoint Bill, however, alone passed on 31 May 1883, coming into operation on 1 December 1884. The Accident Insurance

portion of the original Bill was afterwards resumed in 1884, becoming law on 6 July of that year, and coming into operation on 1 October 1885. Mr. Young further remarks, "These two measures, though in their passage into law disjoined for the moment, retain their original unity, for they have been made co-dependent, the accident insurance supplementing that of sickness, and the period of inability to work constituting the point where the one Act ceases and the other commences."

**Explanation
of apparent
rapid
Elaboration
of German
Law.**

The apparent rapidity with which the laws against Sickness, Accident, and Old Age were elaborated and enacted by the German Government has been frequently remarked upon. In his book on Working Men's Insurance, however, Mr. Willoughby shows that various writers had been dealing with these subjects for years previously to 1884, and so had prepared the way for the introduction of the Government measures. According to Mr. Willoughby, the first definite proposal for the adoption of compulsory insurance seems to have originated with Dr. Schaeffle, about the year 1867. Fourteen years afterwards, that writer published a scheme of insurance in which all the elements were worked out in the minutest details. In this plan can, in fact, be found all the essentials of the legislation now in force.

"Legislation did not, however, create Workmen's Insurance. For more than a generation, insurance constituted one of the definite attributes of the trade guilds, and as such was recognized and regulated by law. The number of insurance funds in existence just before the passing of the law of 8 April 1876, which regulated them anew, was 5,239, with 869,204 members."

**Workmen
must become
Members of
Sick Funds.**

As shown in Mr. Young's paper, a workman is compelled by law to become a member of a local sick fund, a factory sick fund, a building sick fund, a mining sick fund, or a voluntary relief fund. The employer pays, as a rule, one-third of the Sickness Assurance premium, and the workman the other two-thirds.

**Application of
Law of 1884.**

The law of 1884 was originally applicable only to the Industrial Trades (Factories, Foundries, Mines, Quarries, Dock and Building Yards, &c.). It was subsequently extended, in May 1885, to the whole of the post, telegraph, and railway services, to dredging works, carriers, and the like; in May 1886, to agricultural and forestry pursuits; on 11 July 1887, to the building trade; and, on 13 July 1887, to seamen and

others engaged in seafaring pursuits. Officials connected with the foregoing trades come under the Act only if their salary does not exceed 2,000 marks.

Only such persons as are employed in offices as clerks, &c., and who consequently have nothing to do with the practical work, are exempted from this law.

Officials appointed by Government or a public community, and who receive a fixed salary, and are entitled to a pension, are not affected by this law. Such officials, as far as they are employed in a trade or manufactory affected by the "Accidents Insurance Law", are entitled to a pension when they become unfit for service by an accident met with in such employment.

Classes excluded from Operation of Act. Fishermen, domestic servants, and all persons engaged in small industries, carrying on business alone, or employing a few apprentices, are excluded from the operation of the Act.

Contracting Out forbidden. Employers individually, or as trade associations, are positively forbidden by law to restrict, by contract or otherwise, the rights and claims given by law to their workmen.

Cases where Compensation is not allowed. The only cases in which compensation is not allowed are (1) when the injury to the workman does not arise in connection with the execution of his duty in his practical work, as, for example, when he is injured by a fellow workman in a quarrel; or (2) when a workman is convicted of wilfully injuring himself, or of wilfully causing the accident by which he has been injured.

The Sick Funds ("Krankenkassen") provide for the costs of medical care, and support the injured during the first thirteen weeks of incapacity.

Thereafter, the employer is liable for the following compensations :—

I.—To the injured worker—

Amounts of Compensation payable.

(a) Costs of medical care incurred from the commencement of the 14th week after the occurrence of the accident.

(b) An allowance from the beginning of the 14th week after the occurrence of the accident, during the time of his incapacity, the same to be calculated according to the wages last earned. This allowance amounts to

1. In case of total incapacity, and during its continuance, $66\frac{2}{3}$ of the wages.

2. In case of partial incapacity, and during its continuance, a fraction of the rate as per (1), the fraction to be computed in proportion to the remaining wages-earning power.

* II.—To the dependants of the worker, if death results from the accident.

(a) Funeral expenses to the extent of twenty times the daily wages, but not less than 30 marks.

(b) 1. To the widow, till her death or re-marriage, 20 per-cent of the wages.

2. To each child till age 15, 15 per-cent of the wages; and, if the child is already, or becomes, also motherless, 20 per-cent of the wages.

3. To progenitors of deceased, if the latter was their sole support, 20 per-cent of the wages until their death, or until their need of assistance ceases.

These allowances are to commence as from the day on which death occurred, and are to be payable thereafter by monthly instalments.

The allowances to the widow and children are not together to exceed 60 per-cent of the wages; if they exceed that sum, the individual allowances are to be reduced proportionately.

If there are claimants under (3) as well as under (1) and (2), the claim of those under (3) is considered only to the extent that the maximum amount of allowances is not required by the widow and children of the deceased.

In case of re-marriage, the widow shall receive, as final compensation, *three* times the amount of her annual allowance.

Workmen who are not insured must be indemnified by Employer. To those workmen who are not assured in accordance with the regulations of the Sickness Assurance Law, the employer has himself to defray the minimum grants prescribed by the latter law for the first 13 weeks. From the beginning of the fifth week after the accident, until the expiry of the 13th week, the sickness money is to be computed at two-thirds at least of the wages serving as the basis to the calculation. The difference between these two-thirds and the lowest amount of sickness money (one-half) to be granted

* For subsequent alterations on these allowances, see Addendum.

according to law is to be refunded to the Sickness Fund concerned by the owners of the establishment where the accident took place.

Compensation to Foreigners. Foreigners, who permanently quit the Imperial territory, may be paid a sum of money in satisfaction of their claim to compensation. When the family of a foreigner was not domiciled in the country at the time of the accident, it has no claim to any allowance.

Compulsory Insurance. In his paper, to which we have already referred, Mr. T. E. Young remarks as follows:—"In connexion
"with an accident insurance measure previously proposed, the
"Radical party had become alarmed at the development of State
"insurance; and, hence I infer, it was due to this feeling that the
"Government, in the present (1884) measure, proceeded cautiously,
"and abandoned the notion of insurance by the State direct."
Though the Government have not made insurance against accidents compulsory through the State direct, they have really, all the same, made it so indirectly, as the following particulars will show.

Trade Associations. For the purpose of mutually guaranteeing one another against the risks of accidents to their workmen, the employers are grouped by law into Trade Associations ("Berufsgenossenschaften"), and the statutes of each such association must receive the sanction of the Government.

Each branch of trade or industry in which the risks are similar and equal (*e.g.*, iron and steel trade, chemical industry, textile industry, &c.), has been formed by law into a Trade Association for each such branch of industry within a certain geographical district.

Some branches of industry (*e.g.*, the chemical industry, gas and water companies, &c.) have formed only one Association for the whole of Germany. Some other branches (Iron and Steel trade for instance) have formed several Associations, each of them for a certain geographical district.

The total number of Trade Associations in the year 1895 was 112, of which 64 were industrial and 48 agricultural. The former comprised 5,409,218 persons, and the latter 12,289,415; or together 17,698,633. There are also 393 Government Insurance Establishments.

For the obligations of these Trade Associations, the Association's funds alone are liable to the creditors. Trade Associations which are unable to fulfil the obligations required by law may be dissolved by the Federal Council at the request of

the Imperial Assurance Department. The branches of industry which constituted the dissolved Association are to be amalgamated with other Trade Associations according to their nature. At the dissolution, the legal claims and obligations of the Association are transferred to the Empire, or, in individual cases, to the Federal State in respect of whose territory the dissolved Association was established.

Employers alone contribute to Accident Funds. The funds for compensating injured workmen, and the costs of administration, are raised yearly by the employers alone, in proportion to the amount of wages paid by them and the nature of their employment. The workmen are not required to contribute at all to the Accident Funds, although originally, apparently, it was intended that both the workmen and the State should likewise contribute. This idea was, however, abandoned before the Bill became law.

Accumulation of a Reserve Fund. In addition to the sums required to meet the claims and expenses of each year, the Trade Associations are required to accumulate, within the first eleven years, a Reserve Fund by annual instalments, ranging from 300 per-cent of the actual outgo for the first year, to 10 per-cent of the outgo for the eleventh year. After the expiry of the first eleven years, the interest on the Reserve Fund is to be added to it until its amount has reached double the annual requirement,—thereafter the interest may be applied to cover the Association's charges.

Classes of Risk and Contributions. The classes of risk of the various establishments are to be settled by the Associations' General Court, and the contributions by each class of risk fixed by it, subject, in both cases, to the approval of the Imperial Insurance Department. The tariff of risks is to be revised every five years. Unpaid contributions are levied as municipal rates.

The Underground Builders' Association. The Underground Builders' Association, and the Insurance Institutions of the Underground Builders' Associations established in connection with public buildings, have adopted the system of *Capital Covering* owing to the fluctuating nature of the establishments assured by them. This system consists in raising every year the capital value of the permanent allowances which have accrued during the year, and deducting therefrom the capital value of the permanent allowances which have been cancelled during the year. These capital values are calculated according to a Table prescribed by Government for the purpose. The expenses of management, the single indemnity allowances, and the payments of allowances of a temporary nature, are also to

be included in the year's account. The Association members are to make their contributions by quarterly advances.

Injured cannot usually raise Action against Employer.

In ordinary cases of accident, the compensation is payable by the Trade Association, and an injured person can only raise an action for damages for injury against an employer or his manager when the accident has been declared, by criminal verdict, to have been caused by premeditation. In that case, the claim is limited to the amount by which the compensation due to the claimants under existing legal regulations exceeds the compensation to which they are entitled according to this law. Where premeditation or carelessness is proved against the employer or his manager, &c., they are liable for all allowances granted by the Trade Association or sickness fund in consequence of the accident. The injured may, in such case, claim the capital value of the allowance.

Accident Prevention Regulations.

The individual Trade Associations have issued, by virtue of legal authority, accident prevention regulations for their members. By these, they are empowered to punish, on the one hand, neglectful employers by rating them according to a higher class of risk, or by charging some addition to their contributions; and, on the other hand, to inflict fines upon careless workmen.

Inspectors.

For the carrying out of their regulations, the Trade Associations have appointed Inspectors who are bound not to reveal, under pain of severe punishment, any trade secrets coming to their knowledge in the course of their inspection.

The State has also its Inspectors, with whom the Trade Association Inspectors seem to co-operate cordially.

Notification of Accidents.

Accidents causing death or disability to work for a term of more than three days must be notified by the employer to the local police authorities, who must investigate the accident in conjunction with the employer, the representative of the sickness fund, the injured person, and, if need be, witnesses and experts. The costs of these investigations are borne by the Trade Association concerned. Before settlement of the amount of the indemnity, the claimants are given an opportunity of expressing an opinion thereon within a week. Claimants to indemnity, for which the compensation is not fixed by the authorities, have to notify their claims within two years after the happening of the accident under penalty of forfeiture. Appeals are allowed, first to the Court of Arbitration, and thereafter to the

Imperial Assurance Department, whose decision is final. The procedure in both Courts is free of expense.

Court of Arbitration.

The Court of Arbitration is composed of two members of the Trade Association, two representatives of the injured workman, and a presiding Magistrate.

Imperial Assurance Department.

The Imperial Assurance Department is composed of permanent members, consisting of a president appointed for life by the Emperor on the recommendation of the Federal Council, and several higher officers similarly appointed, and temporary members consisting of four delegates from the Federal Council, and representatives of the employers and employed in equal numbers. Two judicial officers are added to assist in the decision of the more important cases.

Indemnities cannot be Mortgaged.

Indemnities may not generally be mortgaged, and they are payable through the Post Office, which recovers the amounts from the Trade Associations.

Results of Working of German Law.

The German Accident Law is the only one of its kind that has been sufficiently long time in existence to give trustworthy indications as to what is likely to be the outcome of its operations hereafter, and the following table, showing the results of its working during the ten years ending 1895, will no doubt prove of interest. The figures are derived principally from Herr Unger's interesting paper included in the Transactions of the Second International Actuarial Congress, supplemented by the Report issued by our own Foreign Office on the operation of the German Insurance Laws for 1895. It will be seen from the table that for the first two years during which the operation of the Law was principally confined to the Industrial Trades, not only is the rate of accident very high, but the accidents resulting in death and complete disability are specially heavy as compared with subsequent years.

Table showing some of the Results of the German Accident Law for the Years 1886 to 1895.

Year	Number of Assured	Out of every 10,000 Assured there were Accidents						Average Amount paid under all the various Classes of Claims
		Notified	Received Compensation	Resulted in Death	Resulted in Permanent Complete Disability	Resulted in Permanent Partial Disability	Resulted in Temporary Disability	
1886	3,725,313	268·9	28·3	7·3	4·8	10·6	5·6	£ 9·0
1887	4,121,537	280·2	41·4	7·9	7·7	20·5	5·3	17·3
1888	10,343,678	133·5	20·5	3·6	2·2	10·7	4·0	22·8
1889	13,374,566	130·7	23·5	3·9	2·2	12·4	5·0	23·0
1890	13,619,750	146·8	30·8	4·4	2·0	16·8	7·6	24·1
1891	17,382,827	129·6	29·5	3·7	1·5	16·2	8·1	25·8
1892	18,014,280	131·2	31·0	3·3	1·5	17·3	8·9	29·1
1893	18,118,850	145·8	34·6	3·5 (3·494)	1·4	20·2	9·5	30·4
1894	18,191,747	155·6	38·3	3·5 (3·497)	1·0	21·7	12·1	31·8
1895	18,389,468	168·7	41·1	3·5 (3·506)	·9	22·4	14·3	33·2

With the extension of the Law to the occupations of Agriculture and Forestry, the rate of accidents receiving compensation at once falls to about one-half of its former rate, though it gradually rises again until it ultimately reaches its early figures in the last year of the table. It is, however, as will be seen, the less serious accidents that account for the increase in the later years. The death rate remains very steadily at about one-half of its figure previously to the extension of the Act, and the accidents entailing permanent and complete disability also decrease considerably and steadily till they reach a satisfactorily low level.

It is to be noted, however, that, though in the early years the serious accidents predominated, the average amount of the claims was lower in these than in subsequent years, and that it is the years in which the accidents resulting in partial disability and temporary disability are most increased that the average claim is highest.

The inference to be drawn from these results would seem to be that the better-paid workmen, who are least subject to serious accidents, are deriving most benefit from the fund, and that there is something like a courting of the less serious accidents for the sake of the compensation involved. Perhaps there is an indication, also, that strictness in the administration of the Law is being relaxed to some extent.

Considering the number of years the Law has been in force, it seems questionable whether the increase in the less serious accidents is due, as has been suggested, to the fact that the provisions of the Law are only becoming known, and that workmen are claiming now for slight injuries which they did not consider important enough even to notify formerly.

While we are dealing with the results thus far of the German Law, we may mention that, according to a French writer, M. Cheysson, the tax on industry in Germany on account of the Accident Assurance Law has been 13·78 per 100 francs of salary paid on the average. And, in the trade of quarryman, it was as high as 28·94 per 100 francs of salary paid. These would seem to be excessively high rates, and we confess we are unable to reconcile them with figures on the same subject in other publications; but they are apparently corroborated in the paper on "Workmen's Accidents in Italy", by S. Luzzati, included in the Transactions of the Second International Actuarial Congress, where it is stated that, between 1886 and 1892, the costs levied upon the employers in Germany, in connection with Accident Insurance, had increased from 4·84 to 12 per hundred units of wages. These figures no doubt include management and Law expenses, but even including them, it is difficult to understand how the rate could be so high. From the Foreign Office Report, it appears that the expenses of current management in connection with the Accident Law amounted for the year 1895 to £336,000, and that further expenses in connection with the fixing of the amount of compensation, Arbitration Courts, &c., amounted to £158,000. The total expenses of management were accordingly £494,000, being 12·9 per-cent of the total income or 22·0

per-cent of the total amount paid in compensation during the year.

We have not, unfortunately, obtained the figures for the year 1895, but for 1896 it appears that out of 160,000 fixations of indemnities by the Trade Associations, there were 38,000 appeals to the Courts of Arbitration, and more than 9,000 appeals to Berlin. From these figures it would appear that litigation is largely responsible for the high expense ratio incurred in connection with the administration of the Law.

From the Foreign Office Report we learn also that the number of assisted persons dependent on workmen who were fatally injured during the year 1895 was 12,800, and of these 4,185 were widows, 8,366 children, and 249 parents or grandparents. The total sum expended in 1896 in compensation for *new* and *old* accidents under the Accident Law was £2,857,720. The bulk of this sum, namely, £2,030,734, consisted of pensions to disabled workpeople, of whom there were 327,270, so that each received on an average £6. 4s. 1d.; £535,438 went in paying pensions to the families of deceased workpeople, 32,982 widows receiving £6. 13s. 6d.; 60,555 children receiving £4. 19s. 4d.; and 2,141 parents, &c., receiving £6. 14s. 2d. each on an average. In addition, 888 widows who re-married received capital sums, amounting on an average to about £23. 10s. each.

Finally, the reserve standing to the credit of the Accident Fund at the close of the year 1895 amounted to no less a sum than £6,249,700. Other results of the working of the German Law might be given, but what has been stated above may suffice in this direction, for the present at least.

We shall now refer to the Laws of some of the other Continental nations which have made the German Law more or less closely their model. And of these Laws we shall begin with

4.—*Austria.*

Early Legislation. The earliest Law in Austria dealing with compensation for accidents is one dated 5 March 1869, and which affects railways only. By it the liability of the employer is *presumed*, and he can only relieve himself from such liability on affording proof that the accident was caused by *vis major*, or owing to an act of negligence on the part of the injured person.

Another Law intended for the protection of workmen is that of 11 June 1883. By that measure, Austria was divided into

Industrial Districts, at the head of each of which an Industrial Inspector is placed. Among other duties, these Inspectors are required to see that the employers adopt proper precautions for the protection of the life and health of their workmen. In cases of default in such precautions, the Inspectors are required to at once inform the local authorities.

Neither of the foregoing Laws provide specially for compensation to workmen injured in the course of their employment, and it may be stated that, until the year 1886, the liability of employers in Austria to compensate workmen for injuries sustained in their service was regulated entirely by the ordinary Civil Law. By that Law it is provided that the employer is only responsible for injuries which may be sustained by workmen when he personally has been the cause of the accident. The employer is not responsible for the acts or omissions of any persons in his service, whether they be overseers or not.

By the Law of 28 December 1887, compensation was for the first time provided for injured workmen, and, in case of the accident resulting in death, for their dependants also. Insurance against accidents is at the same time made compulsory.

A specification is given of the various industries which are to be included in the provisions of the Law, and the Ministry of the Interior has power to add other industries to the list. All workmen employed in factories, foundries, mines, quarries, shipbuilding establishments, as well as in manufactories of explosives, are in accordance with the Law insured against any accidents which may arise. Workmen employed in the building trade are also included, excepting such as may be employed in mere reparations.

On 20 July 1894, the provisions of the Accident Law were extended to Railways and other means of transport of persons and goods by land or on inland waters, the storage of goods, &c.

It is estimated that the Law applies now to about one-sixth of the Austrian labouring classes, and includes especially all who are employed in large factories.

Compensation, out of the Insurance Fund, for injuries commences at the *fifth* week from the date of the accident. The first four weeks are charged on the Sick Funds or Benevolent Societies.

**Basis of
Compensation.**

The compensation is calculated on the rate of annual wages, and such annual wages are estimated at 300 times the daily earnings. If a workman receives more than 1,200 florins (£100 per annum) such excess is not taken into account in arriving at his claim for compensation.

The premiums required to provide the Insurance are borne, 90 per-cent by the employer, and 10 per-cent by the workman.

**Amounts of
Compensation.**

The following are the amounts of compensation allowed by the Act :—

I. To the injured worker, from the beginning of the fifth week—

- (a) In case of total incapacity for labour, 60 per-cent of his yearly wages.
- (b) In case of partial incapacity for labour, an amount not exceeding 50 per-cent of his earnings, but depending on the extent of the incapacity.

II. If death results from the accident—

- (a) Funeral expenses not exceeding 25 florins.
- (b) To the widow or widower (the latter only if he is incapacitated from work) 20 per-cent of the wages of deceased.
- (c) Each legitimate child 15 per-cent ; or, if child has lost its other parent also, 20 per-cent.
- (d) Each illegitimate child 10 per-cent. The allowances to the children are payable until they attain age 15, but they must not exceed altogether 50 per-cent of deceased's wages.
- (e) Progenitors of deceased, if in necessitous circumstances, and deceased was their sole support, may obtain an allowance of 20 per-cent. But, if there be also widow or children, the progenitors are only entitled to an allowance, provided the total payments to the former do not amount to 50 per-cent of wages.

**Cases in which
Compensation
is not payable.**

No compensation is payable to the widow and children if the marriage was contracted after the accident ; or to illegitimate children begotten after the accident ; or to a woman who had lived with the injured unmarried by her own consent.

Accidents incurred intentionally. In cases of accidents proved to have been incurred intentionally, nothing is payable during incapacity, and, in case of decease, the relatives receive one-third less than the usual allowances.

Capitalization of certain Compensations. The compensation to persons of alien nationality may be capitalized, and widows re-marrying have to accept three times the yearly allowance in full of all future claim.

Contracting Out. Employers and workmen are not permitted to contract themselves out of the whole, or any portion, of the provisions of the Law without the assent of the Communal Authorities.

Intimation of Accident. Full details of any accident are to be furnished to the local authorities within five days of its occurrence; and particulars as to the earnings, &c., of the injured person are also to be supplied.

Trade Associations. As in Germany, Assurance Associations have been established by law for providing the payments due to the injured workmen and their dependants. In Austria, however, these Associations are formed, not of those engaged in the same *trade* as in Germany, but of all the employers and employed in a district without distinction of trade. The separate associations, accordingly, include trades differing greatly as regards the frequency of accidents occurring in them. The great reason, or even necessity, for the territorial, in place of the trade, arrangement of employments in Austria is said to be owing to the great diversity of the populations of the Empire, and the desire to group together men of the same language and nationality, rather than those of the same trade only.

The Austrian Assurance Associations are managed by representatives, in equal numbers, of the employers and employed, and not by the employers alone, as in Germany. They have also wider powers of administration than the German, though they cannot make regulations on industry. They can only submit to the public authority, and ask him to confirm, any measures which they consider would be useful.

There are in all seven territorial Assurance Associations in Austria, and the establishment of separate Trade Associations is only permitted in cases where it appears that the business of one or more of the territorial institutions would not be in danger of being injured.

Method of raising Contributions. The insurance contributions are not levied under the assessment system, as in Germany, but, on the

contrary, the Austrian Associations are required, after each accident, to raise a capital sum sufficient to provide the pension due to the injured or his dependants. As a consequence of this system, the recent fall in the rate of interest has had the effect of deranging the provisions hitherto made, and of making the capital sums constituted under them insufficient for their requirements.

Creation of Reserve Fund. In addition to the capital required to provide the compensations, a reserve fund must be accumulated. The contribution to this fund in any year may not, however, exceed 10 per-cent of the whole liabilities.

Apportionment of Contributions. The apportionment of contributions to the various industries included in the separate Assurance Associations is made in proportion to the wages paid, and the risk of accident incurred. As to the latter, a classified table of risks is drawn up, which is subject to revision every five years, as well as the tariff of contributions which the Insurance Institution has to modify according to its requirements. The classification of the risks is made by the Minister for the Home Department. The law originally provided for the "establishment of twelve classes of risk, to which were afterwards added two sub-classes to embrace cases where the risk of accidents is very slight. Each class is then made to include a number of co-efficients of risks, ranging for all the classes combined from 1 to 100. Thus, Class XII includes co-efficients of risks from 81 to 100 inclusive; Class XI from 65 to 80, &c. Each industry is first of all assigned to a class, and, within that class, each establishment has a particular co-efficient of risk, higher or lower, according as there have been many or few accidents in it."

Accidents due to Fault of Employers. When an accident is due to the fault of the employer, the Insurance Association compels him to reimburse it for the indemnity it has had to pay. In the like case in Germany, it will be remembered, the law permits the injured himself to raise the action for damages.

Commutation of Indemnity. The pension to an injured workman can only be commuted into a capital sum with the consent of the Commune, which will eventually be responsible for the relief of the indigent injured person.

The returns available as to the Austrian experience are, for the present, somewhat incomplete, but the following tables, taken from Mr. A. W. Flux's paper, read before the Royal

Statistical Society, will give an idea of the results of the working of the Law for the years 1890-94.

General Results of Years 1890-94 (Austrian Experience).

Year	Average Number Insured	Number Injured, whose Injuries caused				Injuries not awarded Compensation	Amount of Contributions levied
		Temporary Disablement over 4 Weeks	Permanent Disablement		Death		
			Total	Partial			
1890	1,231,818	1,600	100	1,493	518	9,300	£ 315,438
1891	1,369,763	6,068	105	2,016	565	12,532	320,180
1892	1,380,881	6,318	120	2,110	574	16,876	355,838
1893	1,166,270	7,008	115	3,129	649	22,016	379,985
1894	1,598,404	8,181	116	3,585	670	26,689	399,212

This table, with other information as to wage assessment, &c., yields the following result:—

Year	Compensated Injuries per 1,000 Insured	Amount of Contributions levied			Expenses of Management, Arbitration, &c., per £1,000 of Wages	Capitalized Value of existing Obligations
		Per Case of Injury	Per Insured Person	Per £1,000 of Wages		
		£	s.	£	£	£
1890	6.49	46.8	5.12	15.98	1.34	218,478
1891	6.55	36.3	4.67	14.74	1.60	469,168
1892	6.98	37.8	5.15	15.25	1.74	739,380
1893	7.61	34.8	5.18	15.10	1.89	1,051,737
1894	8.02	31.8	5.00	14.74	2.03	1,385,538

It further appears that each fatal accident cost on the average £80; each accident causing total permanent invalidity £237; each one causing partial permanent invalidity £94; and each one causing only a temporary invalidity £5.

The Austrian Law as to the liability of employers to compensate workmen injured in their service follows the German Law perhaps most closely of all the Laws of the other Continental countries which have made that Law their model. The impress of the German Law is not perhaps quite so apparent in some of the other laws which have been influenced by it more or less, and we shall have an instance of this in the next law we are to deal with, namely, that of

5.—*Italy.*

Early Efforts at
Legislation.

There appears to have been in Italy, as in France, many attempts at legislation in regard to labour accidents before a Bill dealing with the matter actually became law.

The first project of law on the subject was apparently laid before the Italian Parliament on 19 February 1883. Besides dealing with the responsibility of employers for accidents, it provided also for a system of National Insurance against injuries, to which reference is made hereafter. The Bill was passed by the Chamber of Deputies on 15 June 1885, but Parliament was prorogued next year before the Senate had finished its debate upon it. Seeing that the proposal referred to was discarded, it is unnecessary, perhaps, to refer to its provisions, though many of these formed the basis of similar enactments in the measure which eventually became law.

National
Accident
Insurance Fund.

Workmen's National Insurance Act.—In connection with the foregoing Law on the responsibility of employers for accidents, a convention was concluded at Rome, on 18 February 1883, between the minister of Agriculture, Industry and Commerce, and 10 of the principal Savings Banks of the country, for the foundation of a National Fund for the Insurance of workmen against accidents incidental to labour. It will be seen that this convention was held the day before the Bill above referred to was brought before Parliament, and evidently in the hope and belief that that measure would at once become Law. There were probably few, if any, Assurance Companies transacting Accident business in Italy in 1883, and the foundation of some such association as the National Fund was, therefore, absolutely necessary for the carrying out of the provisions of the proposed Law. Though the proposed Accident Law was thrown out, the convention for the formation of the National Fund was approved by Parliament, and has done, and is doing at present, a considerable part of the accident business of the country. It may be well, therefore, to give here one or two particulars in regard to it before we take up the other Laws dealing with Employers' liability for accidents.

The convention provides for the establishment of the National Fund as an autonomous corporation to be administered by the Executive Committee of the Savings Bank at Milan.

The amount of the Guarantee Fund subscribed by the parties

to the convention is 1,500,000 lire (£60,000), 1,475,000 lire being subscribed among them, in various sums, by the several banks, and 25,000 lire by the Treasury.

The Government gives gratuitously the service of the Post Office Savings Banks for all the operations of the fund. Freedom from taxation is accorded to it, as well as to the donations, legacies, &c., in its favour, and the transfer of National Debt Bonds to it is free of expense when its capital is being invested in that form of security.

Insurances may be effected by all persons resident in the kingdom who have reached the age of 10 years, and who are employed in manual labour or work by the job or by the day.

The tariffs of the rates of Insurance and of payments are fixed by the Administrative Council of the fund set forth in a due set of regulations approved by Royal Decree, and to be revised every five years.

Every five years, one-half of the net surplus income of the fund is to be apportioned *pro rata* to the persons to whom during that period a compensation has been awarded for *absolute* and *permanent* incapacity for work; and the other half is to be applied in repayment of the Guarantee Fund.

The National Fund will assure against (1) the death of the injured, (2) absolute and permanent incapacity for work, (3) partial and permanent incapacity for work, and (4) temporary incapacity for work exceeding one month in duration.

Insurance may be either individual or collective. Collective Insurance is effected by the employers alone, by employers and workmen together, or by workmen only acting in co-operation.

Having now noticed the formation and establishment of the National Fund, we shall resume consideration of the Laws as to the responsibility of employers for labour accidents.

Following upon the Bill of 1883, various other proposals were brought before Parliament, particularly one in 1893, which required that it should be rendered compulsory upon employers to assure their employees against accidents with the National Fund. None of these Bills, however, succeeded in becoming law. The first measure on this subject, which passed both houses of the Italian Parliament, is dated 17 March 1898, and came into force on 17 September 1898.

Application of
the 1898 Law.

It applies to mines; the building trade; gas, electric and telephone works; to explosive works; to docks and shipbuilding yards; making and working of railways;

transport by river and canal, and lake; tramways; hydraulic works; making and repairing of harbours, canals, bridges, roads, &c. In short, it may be said that the Law is applicable to all workers of Industry employed in manufactories which employ at least *five* persons, and the salaries of whom do not exceed *seven* francs per day.

Assurance by
Employers
compulsory.

The employers in the industries scheduled in the Act must, at their own cost, assure their workers so as to guarantee to them the indemnities provided by Law.

Assurances may
be effected with
National Fund
or Insurance
Offices.

These Assurances may, in ordinary cases, be effected either with the National Fund, or with any private

Company organized in conformity with the regulations of the public administration. Only in the case of persons employed in works executed for the State, the Provinces, and the Communes, does the Law now render Assurance with the National Fund compulsory.

Cases in which
Insurance may
be dispensed
with.

Compulsory assurance is, however, dispensed with in the following cases:—(1) the workers in State

Establishments to which special laws have already secured relief in case of accident; (2) Private Establishments which employ more than 500 workers and which have organized in their favour Assurance Funds recognized by Royal Decree, and procuring to these workers benefits at least equal to those indicated by the law, and which, moreover, have deposited with Government an amount equal to at least five times the annual premium required to assure in a private company; (3) Mechanics joined in an Assurance Syndicate approved by the Minister of Commerce. Such a Syndicate, in order to be approved, must include at least 4,000 workers and pay over to Government a pledge of 10 francs per worker up to a maximum of 50,000 francs. The assessment of members of the Syndicate will be collected as direct contributions, and, in short, the members are solidly responsible for the payment of the indemnities. Special Regulations apply to Railway Companies.

Time allowed
for completing
Insurance.

Two months previous to the coming into effect of the present Law the employers must give in, to the Prefect of the Province, full particulars as to the nature of their industry, number of workmen employed, &c., and, in the following month, the Contract of Insurance must be completed. The employers in new enterprises must assure their workers within *ten* days of beginning work.

Fines in case of Failure to carry out Insurance Obligations.

Employers who fail to carry out the obligation to assure within the required time, or lapse the policy and do not renew it, or do not increase the insurance when the number of their workmen is increased, or erase the conditions of the contract, are punished with a fine of *five* lire for each workman and for each day of delay up to a maximum of 4,000 lire ; and, besides, in case of an accident occurring, they are required to pay the same indemnity to the injured workman as he would have received from the Assurance Society, and, in addition, to hand over a like amount to the Fund to be established by this Act for that purpose in the following terms and for the objects specified, namely :—

Fines and Unclaimed Compensation Fund.

All fines incurred for failures to the Law, as well as the amounts which, in case of the death of the victim, would be due to his dependants will, when these dependants cannot be found, go to form a Fund to be applied to the following uses :—(1) In assisting the workmen who are uninsured because their employers have neglected to assure them, notwithstanding the legal depositions ; (2) To subsidize the Societies which undertake the help of injured workmen during the first five days of their illness ; (3) To subsidize the Associations and Establishments which provide medical assistance to persons injured in their work ; and (4) To provide premiums for the invention of new protective appliances.

Employer may also be liable under Civil Law.

Notwithstanding that the employer has effected the assurance required by the Law, he may still be liable, in addition, to prosecution under the Civil Law if the accident may constitute the basis for a criminal action.

Amounts of Indemnities.

The following are the indemnities provided by the Act, namely :—

- (1) In case of *permanent total* inability the amount payable will be equal to five times the annual wages, and not less, in any case, than 3,000 lire (£120).
- (2) In case of *permanent partial* inability the amount will be equal to five times the *reduction* in the annual wages.
- (3) In case of *temporary total* inability, the allowance will be daily, and equal to the *half* of the average wages, and must be paid throughout the whole duration of the illness commencing from the fifth day.

- (4) In case of *temporary partial* inability, the allowance will be equal to the *half* of the *reduction* in the average wages caused by the effect of the same inability, and will be payable throughout the whole duration of such inability commencing from the fifth day.
- (5) In case of death, the indemnity will be equal to five times the annual wages, and will be paid, according to the rule of the Civil Law, to the testamentary or legitimate heirs.

Employer never relieved from Liability. In default of heirs, the employer is not relieved from liability, but the indemnity will be paid over to the special fund established for that, among other, purposes by the Act. (See page 459.)

Time for paying over Indemnity. The indemnity must in all cases be liquidated and paid over within three months from the day of the accident, and, in case of delay beyond three months, interest must be paid at the normal rate.

Indemnity to Apprentices The indemnity to apprentices is calculated on the basis of the salary of the lowest class of workmen of the same occupation.

Employer liable for Medical Assistance. In every accident, the employer is liable also for the expense of the first medical assistance and medicines.

From the indemnity due in case of permanent inability, partial or absolute, there will be deducted the daily indemnity.

Payment to Infirmary when Injured enters it by consent. When an injured workman enters an infirmary with his own consent, the Assurance Office will hand over to such infirmary a third part of the daily indemnity belonging to the workman.

Prescription of Indemnity. The action to obtain the indemnity established by the present Law is prescribed by the expiry of a year from the day of the happening of the accident.

Indemnity cannot be assigned or sequestrated. The right to the indemnity or to the income cannot be assigned, or pledged, or sequestrated.

Agreements contrary to Law null. Every agreement intended to evade the terms of this Law is null.

Rules as to liquidating Indemnity. For the purpose of liquidating the indemnity in the case of permanent inability, absolute or partial, the following rules shall be observed:—

- (1) Permanent absolute invalidity will be held to consist in the total loss of
 - (a) Two arms or two hands.
 - (b) Two legs or two feet.
 - (c) An arm and a leg; or a hand and a foot.
 - (d) The sight of both eyes.
 - (e) Loss of mental power involving inability to work.
- (2) Permanent partial invalidity will consist in the diminishing in part, but essentially and throughout life, the fitness to work.

In cases of permanent partial invalidity, with a view to the liquidation of the indemnity, the annual salary may be held to be reduced in the following proportions:—

The total loss of the right arm, or the greater part of the arm	80 per-cent.
The total loss of the left arm, or of the greater part of the arm	75 „
The total loss of the right hand, or of five fingers of the right hand, or of the lower part of the right arm, or of a thigh	70 „
The total loss of the same for the left hand and arm	65 „
The total loss of a leg	60 „
The total loss of a foot, or the lower part of the leg	50 „
The total loss of the sight of one eye, together with the serious diminution of the sight of the other eye .	50 „
The total loss of hearing	40 „
The total loss of the sight of one eye .	35 „
The total loss of the thumb of the right hand	30 „
The total loss of the thumb of the left hand	25 „
The total loss of the forefinger of the right hand	20 „
The total loss of the forefinger of the left hand	15 „
The total loss of part of the thumb of the right hand	15 „

The total loss of the little finger of the hand	12 per-cent.
The total loss of the middle, or ring, finger of a hand	8 „
The total loss of a toe or of a joint of a finger	5 „
Inguinal rupture	15 „
Complete deafness of one ear	10 „
For serious mental disturbance, which does not exclude manual labour, the wages may be considered reduced to the extent of	50 „
In case of the loss of several members, the reduction of wages corresponds to the sum of the relative quota of the single reductions, but must not exceed in all	80 „
The total and incurable paralysis of the limbs or of the powers renders them completely useless, and is equivalent to the total loss of them. When instead it renders them only partially useless, the reduction of wages may be considered in the measure directly inferior, and may not go beyond the minimum limit of 5 per-cent.	

- (3) Temporary total inability may be considered as the consequences of an accident which hinders, totally and for a fixed period of time, attendance at work.
- (4) Temporary partial inability is that which diminishes only in part, and for a fixed period of time, the ability to work.

Indemnity for Permanent Total Inability will take form of an Annuity

In case of permanent total inability the indemnity will, as a general rule, be converted into an annuity with the "National Provident Fund for Old Age and "Workmen's Disability", and, until that Institution is founded, with one of the Life Assurance Societies legally doing business in the Kingdom. The Assurance Society will be selected by the victim.

Right of Revision of Indemnity.

The workmen of the Corporations have always the right, within two years, to demand a revision of the trial when the real situation shows that there has been a manifest

error in the first decision, or when the position of the worker has changed.

Assurance
Companies
liable in all
Cases in the
first instance.

Assurance Companies must always pay the indemnity due by them, but they shall have, to recoup themselves, recourse against the employer, or against the worker, in cases where a penal verdict has intervened proving the fault of the employer or the fraud of the victim.

Intimation of
Accidents.

As in the German and Austrian Laws, the accidents must be intimated to the public authority within two days; and the workmen cannot beforehand renounce their benefits under the law.

Employers not included in the scope of this Act, must also give notice within two days of any labour accident to the local authority of public safety, under pain of a fine of from 50 to 100 lire.

Regulations
regarding
Inspectors.

The Government Inspectors are prohibited from undertaking any trade whatever, and in case of their disclosing trade secrets coming to their knowledge in the course of their inspection, they are liable to a fine of from 500 to 1,000 francs.

Such are the chief provisions of the Italian Employers' Liability Act, and one or two points in it are worthy of being specially noticed again before we pass on to the remaining laws we are to refer to of other countries.

Remarks on
Provisions of
Italian Law.

In the first place, then, it will be seen that, in Italy, the indemnity payable in case of the death of the worker as the result of an accident, is fixed altogether independently of his being married or unmarried, or of whether he leaves any, or few, or many children. On consideration, it would appear that there is much to be said for this way of looking at the matter. The employer is not usually benefited in any way by his workman being married and having a family; and, on the other hand, the family of the workman, in the event of their unfortunately losing their bread-winner, is not a greater loser financially, because there are two in place of only one, or three instead of two children. In the case of a workman who marries late in life, and is killed by accident, leaving a young wife behind him, it seems very unfair to the employer to saddle him with the responsibility for an annuity during the remainder of the *widow's* life, and also of providing as well, perhaps, for many years for a young family, when, if the workman had not been killed, his wife and family would have benefited by his

wages only so long as *he himself* was spared, and was able for work. It would seem more in accordance with justice that the compensation payable in the event of an accident entailing death should be a sum down, and that such sum should depend on the age of the workman, as well as on the amount of his wages. It would, perhaps, in most cases, be unwise to hand over any considerable sum to the widow and children of a workman killed by accident, but there would seem to be nothing to prevent the purchase, at the workman's death, with the amount of the compensation, of annuities to the widow for her life, and to the children until the attainment of a fixed age. Such a method of procedure would have the advantage besides of simplifying the calculation of the premiums required for Assurance of Liability Contracts.

Again, the regulations in the Italian Act fixing the proportions of inability to be assumed in connection with the loss of various members of the body must tend to make the administration of the law much more simple and uniform. Vagaries have been noticed in this respect in connection with the working of our own Law, and there is no doubt that some such regulations as are contained in the Italian Law would tend very much to improve matters with us in fixing the amount of compensation payable under our Workmen's Compensation Act.

It would seem that, in Germany, the Miners' Union and Accident Insurance Companies have, in like manner, fixed upon a scale of value to be allowed for injury. According to that scale, loss of a left hand is estimated as causing a reduction of 60 or 70 per-cent of the industrial value; loss of a right hand a reduction of 70 to 80 per-cent; and loss of both hands a reduction of 100 per-cent.

One other point may be referred to. It appears absurd that, in our own and some other countries, because a workman who is killed leaves no dependants, the employer should escape, or practically escape, all responsibility for the results of the accident, even when it may have been due in great measure, or altogether, to his fault. It would seem more logical, as well as juster, to hold the employer responsible in all cases for the indemnity, and to apply the amount, as is done in Italy, for some purpose arising out of the Law, in cases where there are no dependants to hand it over to. The relief from responsibility when there are no dependants, is a distinct inducement to employers to engage only unmarried men. In France, at least, it

is being found that employers are endeavouring to engage, as far as possible, only men who are unmarried; and it seems likely that the fact of a workman being married will, in that country, lead to his finding difficulty in obtaining employment when he happens to be out of a situation.

We proceed now to discuss another law which, as we might perhaps only naturally expect, has been clearly inspired by the German legislation, namely, that of

6.—*Norway.*

Norwegian Law. The first, and apparently the only, Law on the subject of Employers' Liability for Accidents in Norway is that of 23 July 1894.

Application of Law. It enacts that the workmen of most industries (a long list of industries is given in the Bill, and includes factories, mines, ice works, explosive works, building, railways, canals, and nearly every other occupation) will be, except when the injuries are inflicted intentionally by themselves, indemnified (or their families in case of their death) by a State Insurance Fund formed by means of the contributions of the employers.

Insurance Premiums. The amounts of the Assurance premiums payable by the employers, and *by them alone*, are in proportion to the number of workmen they employ and the risk of accidents. The rates of premium are drawn up by the King, subject to the approval of Parliament, and they are revised every five years.

Limit of Wages. Workmen who earn more than 1,200 Kroner (= £66. 10s.) per annum are not included in the scope of the Law.

Inspectors. Local Inspectors are appointed by the Communes to see that the provisions of the Law are carried out, and the employers must furnish them with all necessary information (number of workmen, their wages, &c.), and also advise them of all changes, and of any alterations in the methods of manufacture which may modify the risks of their work.

Indemnities. The right of the injured workmen to an indemnity commences after an incapacity for work of four weeks.

The following are the compensations allowed by the Act, namely :—

I. To the injured worker.

(a) Expenses of sick treatment so long as necessary.

(b) In case of total incapacity, so long as it lasts,

after the first four weeks, 60 per-cent of the wages; but in no case is the allowance to be less than 50 Ore (=7*d.*) per work day, or 150 Kroner (=£8. 5*s.*) for the year.

- (c) In case of partial incapacity, so long as it lasts, after the first four weeks, an allowance proportionate to the extent of the incapacity. The injured is not, however, to receive any allowance unless he is entitled to a payment of at least 5 per-cent of his wages.

II. If death results from the accident.

(a) Burial Expenses of 50 Kroner (=£2. 15*s.*).

(b) An annuity from the day of death of the worker.

(1) To the widow until her death or until re-marriage (or to the incapacitated widower) of 20 per-cent of the wages.

(2) To every lawful child, until it attains its 15th year, 15 per-cent of the wages; or, if the child has previously lost its other parent, 20 per-cent of the wages.

When both parents perish, and have been insured, the children left behind receive 15 per-cent of wages from each of them.

Illegitimate children have the same rights to an indemnity as lawful children.

The annuities of spouses and children must not together exceed 50 per-cent of the wages.

(3) In the case of ascendants whose actual maintainer the deceased was at the time of his death, the compensation payable until their death or until their necessity ceases, is 20 per-cent of the wages. That amount is divided among the relatives alike, yet in such manner that the parent always comes before the grandparent. In case of re-marriage, a widow receives in commutation of her future claims three years' pension.

Dependants of a foreign workman, who, since his decease, have resided beyond the Kingdom, have no right to any indemnities.

Indemnities unassignable and unattachable. Indemnities and pensions are payable by the Assurance Establishment, which is organized and managed by the State, and at its costs. They are unassignable and unattachable.

Capital Covering. Norway has followed the example of Austria in making each year provide for the total costs of the liability incurred in that year. As a result, a capital sum is set aside to meet the future allowances in every case of accident.

Notice of Accident. In case of accident, the employer must advise the Inspector of it, so that he may make the necessary enquiries in regard to it.

Accidents due to Fault of Employer. If the accident arises from the serious or intentional fault of the employer, he may be condemned to an indemnity which will not take away from the workman his Assurance rights, but will benefit the Assurance Establishment by the amount which it is required to pay to the injured.

Employers not liable for Overseers. Employers are not liable for the acts of their representatives, overseers, &c.

Appeals regarding Indemnities. The Assurance Establishment fixes the amounts of indemnities, but the injured can appeal against its decision to a Commission sitting at Christiania. The decisions come to, either by the Establishment or by the Commission, can always be revised if an essential alteration arises in the facts which served to fix the amount of the indemnity.

Capital Allowance in place of Indemnity. If the injured goes to reside abroad, the Assurance Establishment can allow him, in place of his indemnity, a fixed sum representing at least three times the annual indemnity. It can, moreover, allow to the injured who remains in the country, but wishes to engage in business, a capital representing a part, but only a part, of his pension. If the business succeeds, the pension still payable is reduced in proportion to the means which the injured acquires.

Industries involving Special Danger. In the case of industries subject to assurance which present special dangers, a Special Commission points out the precautions which should be observed in their working, and, if these are not followed, or, if the Commission cannot find a remedy for the extra risk, it inserts the workshop in a class of risk requiring an increased premium. The employer has, however, recourse against that decision to the Commission in Christiania already referred to.

Workmen outside Act may insure in National Fund. Workers who are not subject to Assurance by this law may be assured in the official Establishment by their employers, or can assure themselves in it on terms which will be fixed. On the other hand, workmen or employers already assured in private Assurance Companies at the date of this Law, can transfer their rights to the Official Establishment, which will then pay the future premiums, and will have the right to the indemnities from the said Companies when they shall fall due.

Accident Policies may be transferred to National Fund. The one novel and characteristic provision in this law is that which empowers the Assurance Establishment to set the injured up in business with a portion of his indemnity. In considering this provision, we must, of course, remember that Norway is a very different country indeed from our own. There are few large towns in it, and the population is, as a rule, scattered and isolated. In many of the little hamlets, hidden away in their deep valleys, a small shop or store may prove a great convenience to the inhabitants, as well as a profitable undertaking in its way to the person conducting it. It is refreshing to read the paragraph in the law foreshadowing the success of the new venture undertaken by the injured, and his ability, on account of his acquired means, to do after a time with a smaller part of, or even altogether without, his reduced annuity.

Remarks on Norwegian Law. There may, one can imagine, be objections to the scheme,—first, on the part of existing small traders, at the increase in competition for business produced by it; and, second, by maimed shopkeepers and others, who, not having been injured by accident, may resent being regarded as pensioners of the Assurance Establishment.

There is, however, hardly any scheme, especially if it be at all of a social character, to which objections of some sort may not be raised, and one would fain hope that the arrangement here described, which seems to be an honest attempt to bring most benefit practically to those for whose behalf it has been conceived, will prove to be useful and beneficial in its working.

The next country we have to take up is very similar in many respects to that we have just dealt with, though, as it is more industrial in character than the last, its laws will be found to differ somewhat accordingly. We refer to

7.—Switzerland.

Switzerland the first to provide Compensation to Workmen.

Switzerland would appear to have the honour of being the first country to provide compensation to workmen injured in the course of their employment.

Act of 1877.

The Federal Factory Act, which is dated so far back as 23 March 1877, provides that the proprietor of a factory is responsible if an overseer, in the exercise of his functions, occasions, by his fault, an injury to, or the death of, a workman. And, even where there had been no fault by the overseer, unless the accident is found to be due to *force majeure*, or to the fault of the workman himself, the employer is still liable. Should the accident be due partly to the fault of the workman, the damages are to be reduced in a just proportion.

Liability for illness as well as for Accidents.

illness.

In addition to accidents due to labour, responsibility was also extended to industries which occasion serious

Compensations not fixed by 1877 Act.

No specific amounts of compensation were fixed by the Act of 1877, but it is left to the Judge to decide in every case as to the amount of the damages, after taking all the circumstances into account.

Act of 1881.

It was on 25 June 1881 that the first pure Liability Act came into force, and which regulated the execution of the above Articles of the Federal Factory Act.

Some of the provisions of the British Act would seem to have been suggested by this early Swiss Law. For instance, by the latter the liability of the employer is reduced if the workman has acted against the Factory rules, or if he discovered a default in the machinery which was the cause of the accident, without having informed the employer himself or one in authority over him, except the injured man could prove that the employer or the superintendent were already cognizant of the faulty and dangerous condition of such machinery.

It is scarcely necessary to go fully into the other provisions of that law, seeing it has now been superseded. It may just be mentioned that the claim for compensation had to be lodged within one year from the date on which the injury or death occurred. Contracting out was not binding, assurance against accident was not compulsory, though it was pretty generally resorted to, the premiums being payable one-half by the employer and the other half by the workmen.

After experiencing for a year or two the 1881 Law, a somewhat widespread feeling seems to have risen among the Swiss workmen that its provisions were insufficient. A Commission of the Federal Council was accordingly appointed, in May 1886, to look into the matter, and they, in their report, brought forward various propositions as to the amendment of the law.

Law of 1899. It was only, however, in October of last year that a new law was finally promulgated. It consists of a double, or one might even say a threefold, measure, the first part consisting of a Bill providing for sickness assurance, and the second part providing for assurance against accident. There is also a third part providing for similar assurances for the army.

Though dated 5 October 1899, the Law will not come into operation until 1 January 1903.

Application of the Law. Insurance is made obligatory for every person over 14 years of age, carrying on work, otherwise than on his own account, on Swiss territory in any enterprise established in the country. Apprentices, improvers, &c., even if drawing no wages, home workers, domestic servants, and persons employed by the Confederation, or by any public authority or institution whatever, are included. But directors, managers, and other superior officials, whose wages exceed £200 per annum, are exempted from obligation to insure, as also are persons who are employed for less than a week. The obligation to insure may, however, be extended to casual labourers and other persons who are employed for brief periods only, and may also include persons engaged in an industry carried on in their homes on their own account.

Accident Insurance Establishment. The accident portion of the law—with which we shall alone deal here—provides for the creation of a Confederate Insurance against Accident Establishment, with offices in Lucerne. That Establishment is authorized to arrange for the provision of medical care, and the supply of medicines and other medical appliances. The Insurance Establishment will be assisted by an Insurance Council, consisting of from 9 to 15 members, and including at least 3 employers and 3 insured persons.

Accident Fund liable after first six Weeks. After the first six weeks of sickness, the injured is entitled, out of the Accidents Fund, to free medical attendance and sick pay so long as his incapacity lasts. During the first six weeks the medical attendance and sick pay are provided by the Sickness Fund.

Indemnities
fixed temporarily
at first.

In case of accident, the injured receives an allowance for life, or for a fixed limited period. In the latter case, if, at the expiry of the period, the disablement still continues, the allowance is anew fixed, either for life thereafter, or for a further fixed period.

Amounts of
Indemnities.

The following are the compensations provided under the Act, namely :—

I.—To the injured worker, in case either of permanent or temporary disablement, either partial or total, 60 per-cent of the loss of wages.

The Assurance Council is, however, authorized to increase the allowance in the event of the total helplessness of the victim simultaneously with destitution, up to the extent of his full yearly earnings.

II.—If death results from the accident—

(a) Funeral expenses of 40 francs.

If death takes place within the first six weeks, the funeral expenses are met out of the Sickness Fund, but the Accident Fund is bound to make the amount good to the Sickness Fund.

(b) Annuities to dependants, from the day of death of the worker, as follows :—

1. To the widow, until her death or re-marriage, 30 per-cent.
2. To the widower, if unable to work, till his death or re-marriage, 20 per-cent.
3. To each legitimate surviving child till attainment of age 16, 15 per-cent; or, if the other parent be also dead, or dies subsequently, 25 per-cent.
4. To ascendants, for life; and to brothers and sisters, until they attain age 16, in equal shares *per capita*, 20 per-cent together.

If the marriage be not concluded or proclaimed before the accident, there is no title to any allowance; neither is there any claim if the parties were divorced or legally separated.

Illegitimate children are entitled to similar privileges as legitimate from the death of the *mother*.

If the Assurance Council has specially increased the

allowance to the injured, the allowances to the dependants will be increased correspondingly.

The total allowances to dependants must not, however, exceed in all 50 per-cent. When they amount to more, they must be reduced proportionately.

**Grouping of
the Assured
in Classes.**

For the purpose of fixing the allowances, the assured are arranged in classes according to the amount of their daily wages. In all there are ten classes. The first class comprises those assured whose daily wages are under 1 franc; the second, those between 1.01 and 1.50 francs; and so on, each class being .5 franc higher than the preceding, until the tenth class, which comprises those workmen whose daily wages are between 6.01 and 7.50 francs.

**Payment of
Premiums.**

The premiums for the different classes of risks for different occupations are to be fixed by a Risks Table to be compiled by the Federal Office. The employer must, as a rule, pay four-fifths of the necessary premium payable for his workpeople, but he may deduct one-fourth of the amount for which he is liable from their wages. The remaining fifth of the premium is paid by the Federal Government.

**Remarks on
the Swiss Law.**

The one distinguishing feature of the Swiss Law is the regulation which fixes the amount of the indemnity in case of injury only temporarily at the first. In other countries, the indemnity is usually open to revision at any time, but the Swiss method has probably the advantage of saving expense, and also no doubt of preventing the rise of ill-feeling which is often occasioned by one or other of the parties applying for revision of the indemnity.

It does not seem necessary to notice specially any other points in the Swiss Law, and we shall therefore pass on to deal very shortly with the Law of another country, which it will be seen resembles more than those of other countries the British Act in its terms. We refer to

8.—*Denmark.*

**Danish Law
of 1898.
Application
of Law.**

The Danish Law is dated 15 January 1898, and came into operation in January 1899. It is applicable generally to factories, workshops, and other places using machinery; to building, quarrying, &c., but only workmen whose annual wages do not exceed 2,400 crowns (=£133) come under its provisions.

When
Compensation
not payable.

Accidents caused intentionally or by serious negligence do not entitle the injured to an indemnity.

The compensation for injury begins after the first thirteen weeks.

Amounts of
Indemnities.

The compensations payable are as follows:—

I. To the injured himself,

- (a) In case of total temporary disablement, 60 per cent of the wages, but not more than 2 kroner (about 2s. 3d.), or less than 1 krone (about 1s. 1½d.) per day.
- (b) If the incapacity is only partial, the indemnity is reduced in proportion. When the incapacity is permanent, the indemnity is payable in the form of capital. The amount of that capital is fixed at six times the yearly wages, but not less than 1,800 crowns (say £100), or more than 4,800 crowns (say £266. 10s.), any weekly allowance previously paid being deducted from the capital sum.

The injured, when over 30 years of age and under 55, can, however, require the capital to be exchanged for a life annuity.

II. In case of death,

- (a) Funeral expenses of 50 crowns (=£2. 15s.).
- (b) To the dependants of the workman, four years' wages, but not less than 1,200 crowns (=£66. 10s.), or more than 3,200 crowns (=£177).

“Council of
Workmen's
Assurance.”

The right to the indemnity is settled, in case of dispute, by a “Council of Workmen's Assurance”, comprising the President and two members (one of whom is a doctor) named by the King, two employers named by the Minister of the Interior, and two workmen named by the members of the Sickness Fund. In case of death, that Council distributes the indemnity among the various dependants.

Assurance not
Compulsory.

The employer may be his own assurer, and the injured, or his dependants, have only the right against him accorded by the law of bankruptcy. He can always free himself of his risk by assuring with an Insurance Society approved by the State.

Workmen not to Contribute to Insurance Premium. Every agreement requiring the workmen to contribute to the premium for the Insurance, or which would lead in any way to the evasion of the provisions of the Law, is void.

Our next notice refers to the latest of the European States to frame an Employers' Liability Act, namely:—

9.—*Spain.*

That such a country, in its present condition, should turn its attention to this subject is proof of the widespread interest in this matter, and the universal feeling of the need of legislation to protect those who are injured in the service of industry.

Spanish Law of 1900. The Spanish Act is dated January 1900, and the rates of compensation allowed by it are as follows:—

Amounts of Indemnities.

I. To the injured worker.

- (1) Cost of Medical Attendance and Medicines.
- (2) In case of temporary disablement (that is, where the incapacity does not last longer than one year), 50 per-cent of his daily wages until he is able to resume work.
- (3) In case of permanent disablement, that is, disablement lasting longer than a year—
 - (a) If total, a sum equal to two years' wages, if he is unable to engage in any occupation whatever; or eighteen months' wages if he be capable of engaging in a new occupation.
 - (b) If partial, a sum equal to one year's wages, or the alternative of finding him equally remunerative employment at some other kind of work.

II. In case of death.

- (1) Funeral expenses not exceeding £4.
- (2) Compensation to the family of the deceased, which may take the form of a lump sum or of an annuity. In the former case, it varies from two years' wages in the case of a widow with children, to seven months' wages for a parent or grandparent. When awarded in the form of an annuity, the annual payment ranges from 40 per-cent to 10 per-cent of the wages of the deceased.

Increase of Compensation if Workshops not fitted with Safety Appliances.

The rates of compensation are increased by one-half in the case of accidents in workshops not fitted with safety appliances.

Employer must
pay whole
Premium for
Insurance.

An employer may relieve himself of the whole or a part of his liability for accidents by insuring his workpeople with an Insurance Office approved by Government, but the whole of the premium for the insurance must be paid by the employer, and the compensation assured must not be less than that provided by the present Law. Contracting out is forbidden.

Technical
Council.

A Technical Council, consisting of three engineers and an architect, is provided for by the Law to investigate into safety appliances, and to report thereon to the Government.

Workers
excluded
from Law.

Persons engaged in agriculture and forestry are not included in the scope of the Law, except in so far as they are exposed to danger from machinery driven by power.

Preparation of
Rules.

The Rules for giving effect to the Law are to be prepared within six months, and will include regulations, framed with the advice of the Technical Council, specifying those cases in which machinery must be fitted with safety appliances.

Remarks on
Spanish Law.

The compensations allowed by the Spanish Law are of very moderate amount, and many of the provisions in it are, one would think, likely to lead to difficulty and litigation, notably the provision which frees the employer from liability if he finds other employment for the injured.

As will be seen, great importance is attached by the law to the provision of safety appliances in workshops, and in this respect, perhaps, our own and other countries might learn a lesson from Spain, whose motto would seem to be "Prevention is better than cure."

The following particulars are taken from the *Labour Gazette* for October 1897, and refer to the last country whose Labour Law we shall notice, namely :—

10.—Holland.

"According to the *Soziale Praxis* of 9 September, the Government has introduced a Bill for the compulsory insurance of workers in certain trades (including mining, shipping, and transport) against accidents.

"For death the proposed compensation is 10 per-cent of the yearly wages of the deceased as burial money, and a pension, amounting to 30 per-cent of such wages, to the surviving wife, husband, or parent, and 15 per-cent to each child.

"For total disablement it is proposed to give a pension of

“70 per-cent of the yearly wages, and for partial disablement a pension proportioned to the degree of disablement.

“Employers will be divided into classes paying different rates of premium.

“The Bank of Holland is to be responsible for the suitable investment of accumulated Funds.

“The Austrian method of Kapital-Deckung is to be adopted, so that the capitalized value of the obligations incurred during the year will be levied on the employers at the end of the year.”

We have not ascertained what alterations, if any, were made in the proposed Bill, or if it passed into law unaltered, but probably the foregoing particulars may be of interest notwithstanding.*

We have now, we think, besides dealing with our own country, examined the laws regarding compensation to workmen for accidents in all the Continental countries in which the subject has been dealt with by special legislation.

So far as we have been able to ascertain, there are still no special laws on the subject applicable to trades generally in Russia or Belgium. The first country is, however, as yet almost entirely agricultural in character, and naturally therefore the need of special laws in regard to labour accidents is not yet felt to any extent in it. Yet even in Russia, as appears from the paper of M. Pokotiloff in the “Transactions of the Second Actuarial Congress”, there has been legislation on the subject in respect to railway and steamship enterprises, and to Crown mining works. The right to compensation of the injured in Crown mining works was established so long ago as the year 1861. In 1893 a scheme for providing compensation in trades generally was drawn up by the Ministry of Finance, but it has not as yet passed into law.

In Belgium the subject of compensation to injured workmen has been under consideration and discussion for many years, and several Bills have been already foreshadowed, one of which will no doubt very soon become law. As it is, however, Belgium possesses a fund for the assistance of workmen injured by accidents. It was established in 1890, at the special request of the King, with funds that were raised for the purpose of celebrating the 25th anniversary of his ascent of the throne. It was started with an original capital of 2,000,000 francs, and has since been increased by gifts from private individuals and public

* For further particulars of the Bill herein referred to, see Addendum.

bodies. Only the interest of the fund is intended to be used in relieving injured workmen and their families.

Laws in British Colonies. From enquiries we have made on the subject, it would seem that special laws as to compensation of workmen for accidents appear to be generally unknown as yet in the majority of the British colonies and dependencies.* From a note by Mr. M'Gowan, in the "Transactions of the Second Actuarial Congress", it appears that an Act on the subject was passed by the Cape Parliament in 1886, but it is applicable only to mining, and, even then, it is to take effect only within such mining areas as the Governor may from time to time declare by proclamation. The result has been that the Act has, as yet, been put in force only in one district.

A Bill very similar in its terms to, and indeed almost identical in most of its wording with, the British Workmen's Compensation Act, 1897, was introduced into the New South Wales Assembly in November 1899, but it was, we are informed, "thrown out" on its third reading.

There was passed on 19 October 1899, by the New Zealand Legislature, an Act entitled "The Wages Protection Act, 1899," which forbids employers to compel workmen to pay insurance premiums for policies taken out to insure the workmen against "accidents and themselves against liability under the Employers' Liability Acts." In reply to an enquiry on the subject, however, the New Zealand Government Insurance Commissioner states that the New Zealand Workmen's Compensation Act has not yet (April 1900) become law.

State of the Law in the United States. Neither is legislation in regard to workmen's insurance in a more forward condition in the United States of America than it is in the majority of the British Colonies. The Common Law rules in the matter in all the States, with the single exception apparently of Iowa, which has a law providing that "every Railway Company shall be liable for "all damages sustained by any person, including employees of "the Company, in consequence of any neglect of its agents, or "by any mismanagement of its engineers, or other employees of "the Company." Even in Iowa, however, the Common Law applies in all other cases excepting railways.

Mr. W. F. Willoughby, of the United States Department of Labour, in his excellent little book on "Working Men's Insurance", shows how, step by step, all the European nations

* For information as to Laws in British Colonies, see Addendum.

have come to abandon the position that employees have no claim for damages except when they can prove negligence on the part of their employers, in favour of the one where compensation by the employers should be compulsory in all cases excepting where the workmen have been wilfully and seriously at fault. He further refers to the fact that, in Europe, the custom of requiring the amount of the compensation to be fixed in each separate case by the Law Courts is being abandoned, and that, instead, it is being recognized that adequate and prompt compensation can only be secured when the amount of the indemnity is determined in advance. Moreover, he says, it is only as thus organized that employers are able to take account of the risks that they run, and to provide against them by means of insurance.

Mr. Willoughby then goes on to refer to the present position of matters in the United States. He says: "While this movement has been going on in Europe, the United States have practically stood still. Scarcely a beginning has been made towards modifying the unjust provisions of the old Common Law. It is quite beyond our field to attempt any description of the state of the law (*i.e.*, the Common Law) regarding employers' liability in the United States at the present time. The subject is one of great complexity, and here we are concerned with the principle rather than the details of legislation. It is sufficient to say that the United States are in the position where the injustice of the Common Law in respect to this question is more or less recognized, and attempts are being made to bring about a reform through legislation and judicial decisions. The States are thus still in that primitive stage where a solution is sought in the timid modification of the doctrine of common employment; of what constitutes negligence; and other subtleties of the law. They are thus attempting a method of reform long since abandoned by European nations as one which not only does not do justice to the working man, but is thoroughly inadequate to solve the difficulties of the question. It would be difficult to think of another field of social or legal reform in which the United States is so far behind other nations."

The following table will focus much of the information we have given in the preceding pages, and will besides facilitate comparison of the compensations which are allowed to the injured workers and to their dependants by the laws of the various countries we have been dealing with.

Country	Date of Law	Con- pensation commences after	ALLOWANCE TO INJURED IN CASE OF				ALLOWANCES IN CASE OF DEATH						
			TOTAL INCAPACITY		PARTIAL INCAPACITY		Funeral Expenses	Widow	Children	Maximum of Widows and Children's Allowances at which Age cease	Ascendants		
			Permanent	Temporary	Permanent	Temporary							
Britain . .	1897	2nd week	Not exceeding 50 per-cent of Average Weekly Earnings; but not more than £1 per week		Average Weekly Earnings; but not more than £1 per week		Not exceed- ing £10, but only if no dependants	If wholly dependent, 5 years' Wages, but not less than £300 If partially dependent, as may be agreed on, but no more than foregoing.					
France . .	1898	4 days	3ds of Wages	1 Wages	1 of Reduction in Wages	1 Wages	..	20 per-cent, or 20 per-cent	1 Child, legitimate or natural, 15 % 2 Children " " 25 " 3 " " " 35 " 4 or more " " 40 " If both parents dead, 20 per-cent If both parents dead, up to 60 per-cent in all	16	..	10 % each, pro- vided neither Wife nor Child survive. Total not to exceed 30 %	
Germany .	1884	13 weeks	3ds of Wages	3ds of Wages	A fraction of 3ds of Wages in proportion to earning power		20 days' Wages, but not less than 30 marks	20 per-cent	Each Child, 15 per-cent If both parents dead, 20 per-cent	15	60 %	20 % if Allow- ances to Widow and Children do not exceed 60 %	
Austria .	1887	4 weeks	60 per-cent	60 per-cent	Depending on Incapacity, but not exceeding 50 per-cent		Not exceeding 25 florins	20 per-cent	Each legitimate Child, 15 per-cent If both parents dead, 20 " Each illegitimate Child, 10 "	15	50 %	20 % if Allow- ances to Widow and Children do not exceed 50 %	
Italy . .	1898	4 days	Single Pay- ment of 5 years' Wages, but not less than 3,000 lire	Daily Allow- ance of 1/2 Average Daily Wages	S. P. of 5 times re- duction in Annual Wages			Five times the Annual Wages					
Norway .	1894	4 weeks	60 per-cent, but not less than 50 ore daily or 150 kroner yearly	60 per-cent, but not less than 50 ore daily or 150 kroner yearly	Proportionate to Incapacity. No allow- ance if less than 5 %		50 kroner	20 per-cent	Each legitimate or natural Child, 15 % If both parents dead, 20 per-cent If both parents dead and insured, 30 %	15	50 %	20 per-cent	
Switzerland	1899	6 weeks	60 per-cent of the loss of Wages in any case, and this may be increased in case of Total Incapacity	60 per-cent of the loss of Wages in any case, and this may be increased in case of Total Incapacity	Proportionate to the extent of Incapacity		40 francs	30 per-cent Widower, if incapacitated, 20 %	Each legitimate Child, 15 per-cent If both parents dead, 25 " Illegitimate Children participate from death of the Mother	16	50 %	20 per-cent	
Denmark .	1898	13 weeks	60 per-cent	60 per-cent	Proportionate to the extent of Incapacity		50 kroner	Four years' Wages, but not less than 1,200 kroner, or more than 3,200 kroner					
Spain . .	1900	..	2 years' Wages	50 per-cent + Medical At- tendance and Medicines	1 year's Wages	..	Not exceeding £4	Two years' Wages		..	..	Seven months' Wages

General
Agreement to
Charge Slight
Accidents to
Sickness Fund.

It will be seen that, in those countries where there are also Laws as to sickness assurance, the resolution agreed to by the International Congress of Berne, in 1891, has been generally accepted, namely, that slight accidents, causing disablement for a very short time only, should be excluded from the Law relating to accident assurance, and rather brought under that relating to sickness. It will be noticed, on the other hand, that in France and Italy, where there are no Sickness Funds, the compensation for accidents runs practically from the date of the accident.

In our own country, the first two weeks have been excluded, even although there is no National Sickness Fund. It must, however, be borne in mind that the great majority of our workmen are connected with Friendly Societies (in many cases, in fact, with more than one Society), and that no real hardship is entailed upon them in excluding very slight accidents from the benefit of the Act.

Result of
Exclusion of First
Two Weeks in our
own country.

On the other hand, while the exclusion of the first two weeks means really little to the workman, it is of much greater importance to the employer, not only in relieving him of the trouble and annoyance entailed in dealing with trifling accidents, but also in the saving of compensation secured to him. It was stated, I think by Mr. Chamberlain, that the Government considered that the deduction of the first two weeks was equivalent to lessening by 25 per-cent the total number of accidents; and that they agreed with Mr. Neison that the monetary saving effected thereby to the employer was equivalent to five per-cent of the value of the compensation.

III.—ACTUARIAL INVESTIGATIONS AND FORMULAS.

Early Beginnings
of Life
Assurance.

Life Assurance which has now, we may venture to say, secured a place among the sciences, had, as we all know, its origin under very crude conditions. Early assurers were charged a fixed premium of £5 per-cent per annum irrespective of their ages at entry, and, as we of the present day look back, we are apt to wonder how such a charge could have been proposed, far less agreed to. Before, however, we proceed to pass judgment upon the early pioneers of Life Assurance, we must consider some of the conditions by which they were surrounded. They had no past experience to look to, and they had absolutely no statistics to guide them in the

foundation and conduct of their business. The need for Life Assurance had begun to be felt before the advisability or necessity for collecting statistics became apparent. In fact, it was the requirements of the business which dictated the necessity of procuring statistics, and not the possession of the statistics that suggested the starting of Life Assurance.

Original Equal
Life Premium not
an Assessment.

The early promoters of Life Assurance never, I fancy, supposed for a moment that the risk of death is the same at all ages ; and the original equal premium of £5 cannot, therefore, be regarded in the light of an assessment rate, as we are accustomed to think of that term at the present day. It is rather to be looked upon as an average rate of premium, which was known to be more than sufficient over all to meet the claims which would arise. The large surpluses which actually accrued under the system proved that the founders were not mistaken in the assumptions they went upon.

Life and Accident
Insurance
analogous in
their beginnings.

The beginnings of accident assurance in general, and especially of Employers' Liability Assurance, are, in many respects, analogous to those of Life Assurance.

It has presumably been felt of late years that there was an urgent need for protection against the effects of injuries to workmen, and Parliament has accordingly passed laws awarding certain compensations in cases of injury, but without having any very clear indications before them of what are likely to be the results to the employers as regards the cost of the new provisions. Sufficient and suitable statistics have not, and could not, yet of course have been gathered to throw anything like full light upon the subject. For this same reason, those who have hitherto endeavoured to meet the demands for Assurance under the new laws have had to go upon the old plan of a fixed average premium for assurance of workmen of the same occupation, irrespective of their ages at date of assurance. In the meantime, even the Actuary who is called upon to compile, on a scientific basis, rates for the assurance of the benefits which have been secured to the workmen, must find himself pretty much in the position of the unfortunate people who were required to make bricks without straw. Though, however, satisfactory statistics do not yet exist, there are, as we hope to show, sources from which, even now, valuable information may be drawn which should serve as a basis for the compilation of the required tables, at least until the full facts become available.

Very little appears to have been done hitherto even in

attempting to arrive at the rates of premium to be charged for assurances against accident. Before, however, we proceed further with our enquiry, it may be well to refer to what has already been written (actuarially) on the subject.

Previous Investigations. Before the Employers' Liability Act, 1880, became law, the employers connected with mines and railways decided to send a deputation to the Premier in regard to certain of the provisions of the proposed new Bill.

Mr. Neison's Report on Rate of Accidents in Mines and on Railways. For the information of that deputation, Mr. F. G. P. Neison drew up a very clear and interesting report on "The Rate of Fatal and Non-fatal Accidents in and about Mines and on Railways, with the cost of Insurance against such Accidents."

Mr. Neison derived his statistics regarding accidents in mines from the Reports of the Inspectors of mines; and, regarding accidents on railways, from the large Benefit Societies which have been formed in connection with the principal Railway Companies. He found the statistics of accidents on railways supplied to the Board of Trade incomplete and altogether unsuitable for his purpose.

Proceeding "on the assumption that the liability to accident does not vary with each section of any branch of labour, and that it is not affected by the age or social status of the assured, but that, over large masses of labour, these deviations adjust themselves", Mr. Neison states that it is only requisite to know the death-rate per 1,000 employed to be enabled to determine the cost of providing a specific sum in respect of each death occurring. Hitherto, he says, it has not been attempted to apportion the contribution to the precise risk of the individual, but a common average has been adopted which should determine the quota of each member; and probably, until a more exact knowledge of the risk has been attained, this is the best course which could have been followed.

From the statistics compiled by Mr. Neison for his Report, it appears that the death-rate from accident among the coal and ironstone miners of Great Britain was at the rate of 23 per 10,000 employed. In illustration of the statements in the preceding paragraph, he then says, assume that £100—or its equivalent in benefits spread over such period as may be thought advisable—is granted in respect of each one of these claims, then

$$\frac{23 \times £100}{10,000} = \frac{£2,300}{10,000} = £.230 = 4s. 7\frac{1}{2}d. = \text{the premium, or levy,}$$

per person employed on the average of the whole of Great Britain to provide £100 at each death among them from accident within a year.

Again, the death-rate from accident of those employed on Railways, in which there is a heavy goods traffic, was shown in the Report to be 35 per 10,000 persons employed. Therefore, to insure a similar benefit (£100) on the death of each of these 35 would necessitate a contribution of $\frac{35 \times £100}{10,000} = \frac{£3,500}{10,000} = £.35 = 7s.$ per annum in respect of each person assured.

The examples just given have been in respect of a sum payable in the event of the assured dying from an accident, but, as Mr. Neison shows, the principle is equally applicable to a disablement benefit. For instance, the number of miners disabled per annum among those employed in the coal and ironstone mines of this country, has been shown to be at the rate of, say, 1,900 per 10,000 employed; and the average period of their disablement, say $3\frac{1}{2}$ weeks. Assume that an allowance of 8s. per week is to be paid, and therefore the contribution for this risk should be as follows:—

$3\frac{1}{2}$ weeks at 8s. = $\frac{£1. 8s. \times 1,900}{10,000} = \frac{£2,660}{10,000} = .266 = 5s. 4d.$
per annum in respect of each person assured.

A similar benefit for those engaged in railways would cost $3\frac{3}{4}$ weeks at 8s. = $\frac{£1. 10s. \times 843}{10,000} = \frac{£1,264.5}{10,000} = .12645 = 2s. 6\frac{1}{2}d.$
per annum in respect of each person assured.

If it were desired to ascertain the cost of any other benefit, such as an allowance during widowhood to the widow of a member, or a weekly payment to orphans, all that is requisite is to capitalize, at a proper rate of interest, the proposed benefit, and treat it as a sum due at the death of the member.

Of course, the foregoing are what may be termed pure rates, and in practice no doubt some addition would require to be made to them for expenses and contingencies.

Among other matters, Mr. Neison makes it clear that, just as in the case of sickness, accident and disablement rates are found to vary with the locality and other circumstances. He thinks, however, that average rates might be quite suitable for the whole kingdom.

In view of the passing of the 1880 Act, two other papers

Accident, &c.,
Rates vary with
Locality.

were also prepared about that same year. The one, by Mr. Cornelius Walford, "On the number of Deaths from Accident, Negligence, Violence, and Mis-adventure in the United Kingdom and some other Countries", was read before the Statistical Society on 15 February 1881, and we shall refer to it again further on. The other paper was by Dr. Farr, and was published in pamphlet form. Its title was "Rates of Net Annual Premium to cover the Risk of Fatal Accident, according to Age and Sex."

Dr. Farr explains that the rates of premium supplied by him were calculated on the twofold basis of the deaths registered in England and Wales during the 20 years 1851-1870, and the English Life Table.

In a Table (No. 6) of the Supplement to the Registrar-General's 35th Annual Report, there is given the proportion of deaths from violence (exclusive of suicide) to 1,000,000 deaths from all causes at certain groups of ages, among all classes of the population, of both sexes, in the 20 years 1851-1870. These proportions were interpolated for each year of age, and applied to the deaths from all causes at the corresponding ages by the English Life Table. Thus at age 30 (middle age of group 25-35) the ratio of deaths of males from violence to deaths from all causes was as 97,815 to 1,000,000, and the deaths from all causes by the English Life Table were 3,068, so

$$1,000,000 : 3,068 :: 97,815 : 300$$

or $\frac{97,815 \times 3,068}{1,000,000} = 300 =$ the deaths by violence out of 3,068

deaths from all causes at age 30. From the numbers so derived, and termed Vd_x , a column (VC_x) was formed, corresponding with the ordinary Commutation Column C_x . The summation of this Column (VM_x) was then used in conjunction with the N_x of the Life Table $\left(\frac{VM_x}{N_x}\right)$ to determine the premiums required to insure £1 at death by accident, irrespective of profession or occupation. Separate Tables were formed for Males and Females, and at two different rates of interest, namely, 4 and 5 per-cent. It may be interesting to give specimens of the rates of premium derived by Dr. Farr as explained above. They are as follows:—

Specimens from Dr. Farr's Tables of the Annual Premiums payable during Life to insure £100 against Death occurring through Accident.

MALES							FEMALES						
Age	4 per-cent			5 per-cent			Age	4 per-cent			5 per-cent		
	£	s.	d.	£	s.	d.		£	s.	d.	£	s.	d.
20	0	2	0 $\frac{3}{4}$	0	2	0	20	0	0	3 $\frac{3}{4}$	0	0	3 $\frac{1}{2}$
25	0	2	1 $\frac{3}{4}$	0	2	1	25	0	0	4 $\frac{1}{4}$	0	0	4 $\frac{1}{2}$
30	0	2	2 $\frac{3}{4}$	0	2	2	30	0	0	5	0	0	4 $\frac{1}{2}$
35	0	2	4	0	2	3 $\frac{1}{4}$	35	0	0	5 $\frac{3}{4}$	0	0	5 $\frac{1}{4}$
40	0	2	5 $\frac{1}{2}$	0	2	4 $\frac{3}{4}$	40	0	0	7	0	0	6 $\frac{1}{4}$
50	0	2	9	0	2	8 $\frac{1}{4}$	50	0	0	10	0	0	9 $\frac{1}{4}$
60	0	3	0 $\frac{1}{4}$	0	2	11 $\frac{3}{4}$	60	0	1	3 $\frac{1}{2}$	0	1	2 $\frac{3}{4}$
70	0	3	5	0	3	4 $\frac{1}{2}$	70	0	2	3 $\frac{3}{4}$	0	2	3
79	0	4	0 $\frac{1}{2}$	0	4	0	79	0	4	2 $\frac{3}{4}$	0	4	2

The above are, of course, the rates of premium that would be required to secure a sum of £100 at every death from accident, on the assumption that assurance against accidents was made compulsory on the whole population.

Probably the most important actuarial contribution that has been made towards the subject we are considering is a paper by Mr. W. J. H. Whittall, on "The Rates of Fatal Accidents in Various Occupations", which was read before the Institute of Actuaries on 2 January 1882.

Various instructive and interesting tables are given in that paper. They are based upon a comparison of the male population in each occupation in England and Wales, as enumerated at the Census of 1871, with the average of the number of the violent deaths occurring to male persons following that occupation in England and Wales during the three years 1870, 1871 and 1872. Special permission was obtained by Dr. Farr for the extraction of the particulars relating to these deaths from the records of the General Register Office.

All accidents occurring under 10 years of age were disregarded, the population being, of course, similarly treated. Deaths from exposure to cold, homicide, suicide, and executions were also excluded. To make the investigation complete, the whole of the deaths were classified with respect to age; but, as the figures for several of the occupations are small, it was not considered desirable to present the whole of the facts in this respect. The total number of deaths dealt with was 25,276.

Difficulties were found in many instances in properly

classifying the occupations of the killed by accident; and, in other cases, the descriptions were ambiguous—for example, “General labourer (branch undefined).”

The first table deals with those cases where neither the nature of the occupations, nor the results themselves, suggested any disturbing influence. We give specimens of a few of the principal occupations included in this table.

TABLE I.—*Showing, for various Occupations, the Number of Fatal Accidents, in England and Wales, in the Years 1870, 1871, and 1872; the Population (of each occupation) in England and Wales, as enumerated at the Census of 1871; and the Rate of Fatal Accidents.*

Occupation	Fatal Accidents in				Population in 1871	Average Annual Rate of Fatal Accidents per 10,000
	1870	1871	1872	Total of 3 Years		
Grocer	26	26	24	76	88,591	2·9
Printer	13	16	20	49	44,066	3·7
Baker	23	10	25	58	52,724	3·7
Commercial Traveller .	11	9	6	26	17,895	4·8
Stone Merchant, Cutter, Dresser	5	3	1	9	6,046	5·0
Butcher	39	36	41	116	72,675	5·3
Builder	18	14	13	45	23,128	6·5
Aerated Water Manufacturer	1	3	1	5	2,409	6·9
Hotel-keeper	58	55	47	160	74,367	7·2
Joiner	150	157	177	484	205,615	7·8
Physician	13	14	14	41	14,684	9·3
Slater	9	2	7	18	6,078	9·9
Horse Proprietor . . .	1	2	3	6	1,364	14·7

Mr. Whittall remarks that it is not contended that the “average rate” which has been placed against each occupation shows the exact rate of fatal accidents applicable to persons of that occupation. There are several reasons against this, he says :—

1. There is a possibility of errors in the observations.
2. The years under observation may not have been average years.
3. In many occupations, the rate of fatal accidents is constantly changing owing to alterations in methods of manufacture, &c.
4. In a great number of occupations the numbers exposed to risk are so small that they cannot be said to possess any ascertainable rate of fatal accidents at all.

Nevertheless, Mr. Whittall thinks the table may at least be used as a rough guide, which is sometimes better than no guide at all.

It seems to us that, if the rates of fatal accident in one occupation were exactly determined at all ages, such a table as Mr. Whittall has compiled would supply a very important factor in determining the percentage by which the rates for other kindred occupations might be increased or diminished, and thus save the labour of preparing at length tables for every branch of industry.

We shall notice only two other points—and they are very important—brought out in Mr. Whittall's paper. They are, first, that nearly all classes of workmen are subject to a considerable fatality from accident independently of their occupation. For example, the following are the percentages of fatal accidents *in connection with occupation* to the total fatal accidents in the several occupations referred to, namely:—Blacksmith, 35 per-cent; builder, 49 per-cent; butcher, 22 per-cent; joiner, 53 per-cent; miner, 85 per-cent, &c.; and second, that the liability to accident is not constant for all ages, but that it varies with the age attained. Mr. Whittall's last table, of which we give specimens, shows, for certain occupations and groups of ages, the population (of the occupation) in 1871, and the fatal accidents in 1870, 1871, and 1872 in England and Wales, and the rates of fatal accident; distinguishing those considered to have occurred in connection with the occupation:—

Occupation	Age	Population in 1871	Fatal Accidents 1870-2		Average Annual Rate per 10,000		Per- centage
			In Con- nection with Occupation	Total	In Con- nection with Occupation	Total	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(6) of (7)
Carpenter	10-20	31,076	16	54	1·7	5·8	29
	20-45	117,298	123	207	3·5	5·9	60
	45-65	44,539	84	150	6·3	11·2	56
	65 upwards	12,702	33	73	8·7	19·2	45
Mason	10-20	15,109	13	32	2·9	7·1	40
	20-45	53,927	64	101	4·0	6·2	65
	45-65	21,027	43	83	6·8	13·2	52
	65 upwards	5,125	16	31	10·4	20·2	51
Plumber Painter Glazier	10-20	17,508	11	24	2·1	4·6	46
	20-45	63,338	114	181	6·1	9·6	64
	45-65	19,550	94	121	16·0	20·6	77
	65 upwards	2,986	19	30	21·2	33·5	63

As regards the age groupings, Mr. Whittall says: The first, ages 10–20, would represent the periods of youth and apprenticeship, naturally characterized by want of thought and inattention to precaution. The rates shown by this grouping are generally, as might be expected, higher than those brought out by the next. The second grouping, ages 20–45, would represent the period of life in which the worker should be in his prime. The third, ages 45–65, covers the period when muscular and vital force is declining and activity is abating. The fourth includes those whose fast-failing strength would render them peculiarly liable to accidents.

Throughout the Table there is, generally speaking, a marked and steady increase in the rates for the last three groups in almost every occupation. That is to say, the rate is usually higher in the first period, falls in the second, and rises again in the other two groups. It is curious, however, to notice that the percentage of accidents in connection with occupation as compared with the total accidents is generally highest in the second group. That is to say, it is apparently at ages 20–45 that men devote themselves to their business more entirely than at any other ages.

Unsuitability of
Registrar-
General's
Statistics.

Two conclusions are evident from this last Table of Mr. Whittall's. They are, first, that any statistics, such as those of the Registrar-General, which do not distinguish between accidents which occur in connection with the occupation and apart from it, are practically useless in forming Tables to be used in connection with fixing the premiums to be charged for assurance of the benefits guaranteed by the Employers'

Liability to
Accident not
Constant at all
Ages.

Liability Act. Second, the liability to accident is *not* constant at all ages, and, therefore, in charging a uniform premium for workmen of different ages in the same occupation, an injustice is done to employers who have a preponderance of young workmen. This will be the case probably where firms have only recently begun business, while old-established firms, having a large number of workmen up in years, are charged less than their fair share of the correct premium over all for the risk.

Comparison of
Risk Premium
and Assessments.

To show the difference between an assessment premium, and a premium calculated according to the risk, the following example may be useful. We have not an Accident Mortality Table to make use of, but we shall assume that the number of deaths according to the H^M Table

will occur. According to the Census of 1891, there were 61,215 males alive between ages 25 and 65.

Of these, 37% or 22,586 were aged 25-35, say aged 30 on the aver.

„	28% or 17,418	„	35-45	„	40	„
„	21% or 12,885	„	45-55	„	50	„
„	14% or 8,326	„	55-65	„	60	„

Therefore, of 10,000 living between ages 25 and 65 there will be living at

Age 30, 3,700, and of these according to the H ^M Table	} 28
there will die in a year . . .	
„ 40, 2,800	29
„ 50, 2,100	33
„ 60, 1,400	42
<u>10,000</u>	<u>132</u>

If each of the 132 who die is assured for £100, a total sum of £13,200 will require to be raised. This may be done by an equal contribution over the 10,000 workmen of £1. 6s. 5d. irrespective of their various ages. Or, if the contribution be according to age, the state of the case will be as follows:—

The 3,700, aged 30, will contribute £2,800 among them, or about 15s. 2d. each.

The 2,800, aged 40, will contribute £2,900 among them, or about £1. 0s. 9d. each.

The 2,100, aged 50, will contribute £3,300 among them, or about £1. 11s. 5d. each.

The 1,400, aged 60, will contribute £4,200 among them, or about £3 each.

An assessment equal at all ages, therefore, has the effect of making the members of the two younger groups pay respectively 11s. 3d. and 5s. 8d. more each than they should do; while the members of the two older groups are each relieved of 5s. and £1. 13s. 7d. respectively of their proper contributions.

As is well known, Liability Insurance Companies universally charge at present a certain rate of premium on the amount of wages paid altogether irrespective of the ages of the workmen employed. It would seem, too, that, after an office has been several years in existence, and the risks upon its books have also increased in age, there will be a tendency for such risks to include year by year a relatively larger proportion of workmen more

advanced in age. As a result, the office is likely to find, after a few years, that its claims are not being met by the annual contributions. On the other hand, if the premiums were correctly levied according to the age at entry of the workers, a reserve would have to be accumulated to meet the increasing risk in after years. The necessity for such a reserve has already, as we shall see, been made very apparent in Germany and Austria, and it is to be feared that too little attention has been, or is being, paid to this matter in our own country. Of course, as business is at present being conducted with us, the Insurance Offices have the option to refuse to renew at the end of the year risks which are found to be unprofitable; but it must be a serious matter for them if they have to resort to this procedure frequently. It is to be feared, however, that before long they will have, under the present system, to choose between frequent refusals to renew, and the ability to carry on business at all.

M. Maingie's
Paper.

So far as we are aware, the only public reference to the Actuarial aspects of the compensations provided for by the various recent laws we have had under consideration is in the paper on "Compensation for Workmen's Accidents in Belgium", by M. Louis Maingie, and which is included in the Transactions of the Second International Actuarial Congress. It may be useful to reproduce here M. Maingie's reference to the subject. He says, "representing by V_m , V_p , V_t , the probabilities, "having reference to the term of one year, of an accident causing "death, permanent disablement, or temporary disablement; by " ${}^{(m)}A_x$, " ${}^{(p)}A_x$, " ${}^{(t)}A_x$ the values at the beginning of the year of the "corresponding benefits to an assured aged x in case of accident; "the premium p_x requisite to protect for one year an assured "aged x is

$$p_x = V_m {}^{(m)}A_x + V_p {}^{(p)}A_x + V_t {}^{(t)}A_x.$$

"In practice the problem does not appear in a form so simple. "It is often not easy to determine the values of V_m , V_p , V_t , for a "particular industrial trade. Therefore, we must content "ourselves with finding the probabilities of accident for trades "as a whole, provided that we multiply each of them by a "coefficient of special risk."

M. Maingie then goes on to state that Austria has not acted on the foregoing principles. "There, it has been proposed to "assimilate the rates of contribution for workmen of different "ages, to whom would be applied the same coefficients of risk."

The following is shown to be the method of calculating the rates of contribution in Austria.

“ If we represent by C_1, C_2, C_3 , the coefficients of risk, the “ rate of contribution per unit of wages for trades affected by “ these coefficients are found by the formula—

$$“ p_1 = KC_1; p_2 = KC_2; p_3 = KC_3 \dots$$

“ K being the rate of contribution for a unit of wages, with unity “ for the coefficient of risk.

“ K was found as follows :—Let Q be the average rate per “ unit of wages,

$$“ Q = \frac{p_1 s_1 + p_2 s_2 + \&c.}{s_1 + s_2 + \&c.} = \frac{\sum p_n s_n}{\sum s_n} = \frac{K \sum C_n s_n}{\sum s_n} \dots (1)$$

$$“ \text{Therefore } K = \frac{Q \sum s_n}{\sum C_n s_n} \text{ where } s = \text{the wages} \dots (2)$$

“ The value of K thus depends on the average rate of “ contribution, which was calculated as below ; the value of p_x “ being given by the formula—

$$“ p_x = V_m^{(m)} A_x + V_p^{(p)} A_x + V_t^{(t)} A_x$$

$$“ \text{It was assumed that } Q = \frac{\sum n_x p_x}{\sum n_x} \dots (3)$$

“ n_x being the number of assured aged x .”

M. Maingie goes on to show that the method just set forth possesses serious defects. “ One of the most important of the “ defects is that the foregoing formulas are inconsistent with “ each other. While the average rate of contribution given by “ formula (1) is sufficient to cover the risk of accidents and pay “ the compensation calculated on the effective wages, the average “ rate of contribution given by formula (3) assumes all the wages “ to be equal to unity. There is, therefore, no relationship “ between these formulas. The rate of contribution given by “ formula (3) is, therefore, only approximate, and it would be “ difficult to determine the degree and sign of approximation.”

M. Maingie also protests against “ the entirely needless “ introduction of the deplorable idea of average in the application “ of the law.”

Finally, he objects that as “ the contribution per florin of “ wages, and per unit of coefficient of risk, is derived from the “ equation

$$“ K = \frac{Q \sum s_n}{\sum C_n s_n}$$

“if the variations of wages in each class of risks are not proportionate, this equation has no longer any meaning.”

Having, as far as we are aware, gone over in the preceding pages all that has already been written in connection with the subject under consideration, we shall now proceed to endeavour to derive, as far as we can, suitable formulas for the calculation of the compensation benefits provided for under the various Labour Accident Laws recently passed in our own and other countries.

From the table on page 479, it will be seen that the compensations provided for by the Law of Great Britain are materially different from those allowed by the Laws of the Continental countries; and, on that account, as well as for other reasons, it will perhaps be better to deal first of all, and separately, with the Law of our own country. The compensations provided by the British Law are, it will be seen—

I.—In case of death—

- (a) If the worker leaves dependants wholly dependent on him, three years' wages, but not less than £150 or more than £300, any weekly payments made to the injured being deductible.
- (b) If the dependants are only partially dependent, a sum proportionate to the loss to such dependants, but not exceeding the amounts provided for in (a)
- (c) If there are no dependants, funeral expenses not exceeding £10.

II.—In case of incapacity to work, a weekly payment after the second week—

- (d) In case of total incapacity, not exceeding 50 per-cent of the average weekly wages, and not more than £1.
- (e) In case of partial incapacity, in proportion to the loss of wages.

Meaning of
the term
“Dependant.”

We may notice that, by the term dependant, is to be understood, in England or Ireland, wife or husband; father and mother; grandfather and grandmother; stepfather and stepmother; sons and daughters; grandsons and granddaughters; stepsons and stepdaughters. And, in Scotland, the term covers husband or wife; father and mother; sons and daughters.

To calculate exactly the benefits detailed under I, it would

appear that we should require to know, not only the probabilities of death resulting from accident at every age in various occupations, but also the probabilities that workmen killed by accident will leave at least one of the above specified dependants either totally or partially dependent on him at the time of his death. To arrive at the latter probabilities we would require to have statistics of marriages; and of such marriages entered into by men of all ages becoming fruitful; the number of children to each marriage on the average, and that such children will marry and have issue. We would require to know also, not only the relative ages of husbands and wives, but also of parents and children, grandparents and grandchildren, &c. Further, we must have statistics as to the degrees of dependence of the surviving relatives of workmen killed by accident.

It is manifest, I think, that such statistics as are referred to in the foregoing paragraph are not likely to be all forthcoming, and we must therefore seek for some shorter way out of the difficulty. It may be possible to obtain statistics as to cases in which workmen killed by accident have left dependants (without specifying their precise relationship) either totally or partially dependent on them. Probabilities of marriage are also procurable.

Symbols.

In seeking for the necessary formulas we shall make use of the following symbols, namely:—

Let d'_x = the number who are killed by or die from the result of accident between ages x and $x+1$.

$(pm)_{x+t}$ = the probability that at age $x+t$ a man will be married.

$(pmr)_{x+t}$ = the probability that at age $x+t$ a married man will have relatives partially dependent on him.

$(pm\hat{r})_{x+t}$ = the probability that at age $x+t$ a married man will have relatives wholly dependent on him.

$(pb)_{x+t}$ = the probability that at age $x+t$ a man will be still a bachelor.

$(pbr)_{x+t}$ and $(pb\hat{r})_{x+t}$ = the probabilities respectively that, at the same age, being a bachelor, he will have relatives partially or wholly dependent on him.

Q = the average proportion of liability where the relatives are not wholly dependent on the killed.

s = wages for a year. If s be taken equal to 52 (£1 per week) in formulas, the value for any other rate of wages will be readily found.

It seems tolerably certain that the probabilities of bachelors and married men leaving dependants will differ materially, and we should accordingly deal with them separately. It would seem, however, to be unnecessary to distinguish between the probabilities of death or injury by accident of bachelors and married men, as these are likely to depend altogether upon the age attained, and not upon the condition of life of the victim at the time. Under the term married men we shall include widowers.

Assume 3 years' wages as the sum payable at death; £10 as the funeral allowance; and the weekly payment for total incapacity 50 per-cent of average wages (s).

Formulas.

$$(1) \text{ Let } B(b)_x = v^{x+\frac{1}{2}} d'_x \{ (pm)_{x+1} [(pm\hat{r})_{x+1} + Q(pm\hat{r})_{x+1}(1 - (pm\hat{r})_{x+1})] + (pb)_{x+1} [(pb\hat{r})_{x+1} + Q(pb\hat{r})_{x+1}(1 - (pb\hat{r})_{x+1})] \}$$

$$(2) \text{ Then } \frac{B(b)_{x+n}}{D_x} = \text{value of 1 payable at the death by accident between ages } x+n \text{ and } x+n+1, \text{ leaving dependants, of a workman who is presently unmarried.}$$

$$(3) \frac{K(b)_x}{D_x} = \frac{B(b)_x + B(b)_{x+1} + \&c.}{D_x} \\ = \text{value of 1 similarly payable at any time after age } x.$$

$$(4) \frac{I(b)_x}{D_x} = \frac{K(b)_x + K(b)_{x+1} + K(b)_{x+2} + \&c.}{D_x} \\ = \text{value of an increasing assurance of 1 with the same conditions.}$$

If a workman is already married, $(pm)_{x+1}$ will become equal to unity, and $(pb)_{x+1}$ will equal 0 in (1), and we shall have—

$$(5) \quad B(m)_x = v^{x+\frac{1}{2}} d'_x \{ (pm\hat{r})_{x+1} + Q(pmr)_{x+1} (1 - (pm\hat{r})_{x+1}) \}$$

$$(6) \quad \frac{K(m)_x}{D_x} = \frac{B(m)_x + B(m)_{x+1} + \&c.}{D_x}$$

=value of 1 payable at the death by accident, at any time after age x , of a married workman, provided he leave dependants either wholly or partially dependent on him.

$$(7) \quad \frac{(Im)_x}{D_x} = \frac{K(m)_x + K(m)_{x+1} + K(m)_{x+2} + \&c.}{D_x}$$

=value of an increasing insurance of 1 with the same conditions.

In the above formulas it is perhaps unnecessary to distinguish between total and partial dependency. It may be sufficient to deal simply with the proportion of dependency brought out under both classes, and, in that case, formula (1) would become—

$$B(b)_x = v^{x+\frac{1}{2}} d'_x \{ (pm)_{x+1} Q(pmr)_{x+1} + (pb)_{x+1} Q(pbr)_{x+1} \}$$

and formula (5) may be written—

$$B(m)_x = v^{x+\frac{1}{2}} d'_x \cdot Q(pmr)_{x+1}$$

Or, again, it may be found over all that, if a man is married, the probability of his leaving relatives wholly dependent on him approaches unity, and, accordingly, formula (1) may be written approximately—

$$(8) \quad B(b)_x = v^{x+\frac{1}{2}} d'_x \{ (pm)_{x+1} + (pb)_{x+1} [(pb\hat{r})_{x+1} + Q(pbr)_{x+1} (1 - (pb\hat{r})_{x+1})] \}$$

and, similarly, formula (5) may be written approximately—

$$(9) \quad B(m)_x = v^{x+\frac{1}{2}} d'_x.$$

The foregoing formulas assume the assurances to run throughout life. If they are only to run till a certain fixed age, formula (3) will become—

$$(10) \quad \frac{K(b)_x - K(b)_{x+n}}{D_x}$$

and formula (6) will become—

$$(11) \quad \frac{K(m)_x - K(m)_{x+n}}{D_x}$$

If the benefits are to be paid for by an annual premium, we shall have to substitute in the foregoing formulas N_{x-1} for D_x if the premium be payable during life; or $N_{x-1} - N_{x+n-1}$ if payable only till a fixed age. (Or N_x and $N_x - N_{x+n}$ if we make use of the English Life Tables for these functions.)

The formulas for the values of the funeral expenses may be expressed as follows:

$$(12) F(m)_x = v^{x+\frac{1}{2}} d'_x \{ (1 - (pm\hat{r})_{x+1}) (1 - (pmr)_{x+1}) \}$$

$$(13) \frac{G(m)_x}{D_x} = \frac{F(m)_x + F(m)_{x+1} + F(m)_{x+2} + \&c.}{D_x}$$

=value of £1 payable at the death by accident of a married workman if he leave no dependants.

$$(14) F(b)_x = v^{x+\frac{1}{2}} d'_x \{ (pm)_{x+1} (1 - (pm\hat{r})_{x+1}) (1 - (pmr)_{x+1}) + (pb)_{x+1} (1 - (pb\hat{r})_{x+1}) (1 - (pbr)_{x+1}) \}$$

$$(15) \frac{G(b)_x}{D_x} = \frac{F(b)_x + F(b)_{x+1} + \&c.}{D_x}$$

=value of £1 payable at the death by accident of a workman presently unmarried if he leave no dependants.

In arriving at the values of the benefits provided in case of permanent incapacity, not resulting in immediate death, we shall make use of the following additional symbols :

$\frac{1}{2} \overset{(52)}{\underset{6}{\mid}} a' \overline{\square}_{x+\frac{1}{2}}$ = the value of an annuity of 1 to a workman who is partially and permanently incapacitated by accident at age $x + \frac{1}{2}$ to be payable weekly, first payment to be made at the end of three weeks from date of accident.

$\frac{1}{2} \overset{(52)}{\underset{6}{\mid}} a' \overline{\square}_{x+\frac{1}{2}}$ = the value of a similar annuity to a workman who is totally and permanently incapacitated at the same age.

$(p\hat{i})_x$ = the probability of a workman being totally incapacitated at age x .

$(pi)_x$ = the probability of a workman being partially incapacitated at age x .

Then, assuming that the allowance to the injured in case of total incapacity will be 50 per-cent of his wages (s), and that the

compensation to the relatives will be three years' wages, less the amount of the annuity payments drawn by the injured—if these do not amount to three years' wages—we shall have for the approximate value of the whole benefit, if the injury be sustained in the n th year,

$$\begin{aligned}
 (16) \quad \overset{\circ}{Z}(b)_{x+n} &= v^{x+n+\frac{1}{2}} l_{x+n} (\overset{\circ}{p}i)_{x+n} \left\{ \frac{1}{\frac{1}{2} \cdot 6} \left[\overset{(52)}{a'}_{x+n+\frac{1}{2}} \right] \times \frac{1}{2} \right. \\
 &\quad + 3(K(b)_{x+n+\frac{1}{2}} - K(b)_{x+n+6\frac{1}{2}}) - \frac{1}{2}(I(b)_{x+n+\frac{1}{2}} \\
 &\quad \left. - I(b)_{x+n+6\frac{1}{2}} - 6K(b)_{x+n+6\frac{1}{2}}) \right\} \\
 &= v^{x+n+\frac{1}{2}} l_{x+n} (\overset{\circ}{p}i)_{x+n} \left\{ \frac{1}{\frac{1}{2} \cdot 6} \left[\overset{(52)}{a'}_{x+n+\frac{1}{2}} \right] \times \frac{1}{2} \right. \\
 &\quad \left. + 3K(b)_{x+n+\frac{1}{2}} - \frac{1}{2}(I(b)_{x+n+\frac{1}{2}} - I(b)_{x+n+6\frac{1}{2}}) \right\}
 \end{aligned}$$

the workman being assumed to be presently unmarried.

The last term of the expression is only approximately correct. The exact value will require the calculation of an assurance increasing weekly under the conditions specified as to totally dependent and partially dependent relatives. The calculation of such a function would, however, be attended with considerable labour, and also with very great difficulty.

Mr. Manly, in a very interesting and ingenious paper printed in the Transactions of the Second Actuarial Congress, has investigated a problem somewhat similar to that comprised by our formula (16). Mr. Manly's problem is: To find the price of an immediate annuity of 1 on the life of x , with the condition that if the life should die before the payments amount to the price given, the balance between the price given and the total annuity payments shall be returned.

With the altered symbols and slightly altered conditions, the result here brought out seems to be very similar to that arrived at by Mr. Manly.

$$\begin{aligned}
 (17) \quad \frac{\overset{\circ}{V}(b)_x}{D_x} &= \frac{\overset{\circ}{Z}(b)_x + \overset{\circ}{Z}(b)_{x+1} + \overset{\circ}{Z}(b)_{x+2} + \&c.}{D_x} \\
 &= \text{value of the same benefit as in (16) should the} \\
 &\quad \text{accident occur at any time after age } x.
 \end{aligned}$$

$$\begin{aligned}
 (18) \quad \frac{\overset{\circ}{V}(b)_x - \overset{\circ}{V}(b)_{x+n}}{D_x} \\
 &= \text{value of the benefit if the accident occur} \\
 &\quad \text{between ages } x \text{ and } x+n.
 \end{aligned}$$

If the workman is already married, we shall simply have to substitute $K(m)$ and $I(m)$ for $K(b)$ and $I(b)$ in formula (16) to obtain $\frac{\overset{\circ}{V}(m)_x}{D_x}$ the value of the benefit on a married workman.

If the workman is only partially incapacitated, his death is not so likely to result from the accident; and, even in the few cases where it does so result, it is probable that the workman will have drawn a good few payments of his annuity before his decease. We may safely, therefore, perhaps neglect taking account of any benefit to the dependants of the workman who is only partially incapacitated. The value of the benefit in his case may therefore be expressed as follows:

$$(19) \quad Z_{x+n} = v^{x+n+\frac{1}{2}} l_{x+n}(pi)_{x+n} \overset{(52)}{a'_{\frac{1}{2}|x+n+\frac{1}{2}}} \times Q$$

= value of annuity of the proportion of his wages of 1 to a workman if he is partially and permanently incapacitated by accident between age $(x+n)$ and age $(x+n+1)$. This formula will therefore apply both to married and unmarried men.

$$(19a) \quad \frac{V_x}{D_x} = \frac{Z_x + Z_{x+1} + Z_{x+2} + \&c.}{D_x}$$

= value of same benefit if the accident occur at any time after age x .

$$(19b) \quad \frac{V_x - V_{x+n}}{D_x} = \text{value of the benefit if the accident occur between ages } x \text{ and } x+n.$$

Value of Annuity on Partially Incapacitated Workman. The value of the annuity on a workman who has been *partially* and permanently incapacitated, will, of course, depend on the extent of the incapacity, and will differ widely in different cases. The value may, however, be easily arrived at by interpolation between the value of an annuity on an entirely healthy life, and one on a *totally* incapacitated life. For instance, if a workman's wages are found to be permanently reduced, on account of accident, by one-third of their former amount, the value of an annuity on his life will be found by subtracting from the value of an annuity on a healthy life of his age, one-third the difference between the value of that annuity and an annuity on a totally incapacitated life of the same age.

The expression $a'_{\overline{x+\frac{1}{2}}}$ the value of an annuity on a life who has just been injured by an accident at age $x + \frac{1}{2}$, is analogous to the expression $a_{[x+\frac{1}{2}]}$ the value of an annuity on a select life. We shall see later on that the value of $a'_{\overline{x+\frac{1}{2}}}$ approaches, after a few years, to the ordinary annuity-value for an uninjured life of the same age. The reason for this is, of course, that a workman who loses a hand or a foot, or a leg or an arm, or even both legs or arms, if he recovers from the shock, and makes a satisfactory recovery, is likely, if he lives a year or two and keeps in good health, to live at least the average lifetime, or perhaps longer, seeing that he will have thereafter less work to do, or even no work if he is totally incapacitated; and will have, moreover, a sure provision made for him for the remainder of his days.

Temporary Incapacity. To arrive at the values of the benefits to be allowed in case of *temporary* incapacity through accident, either total or partial, we require to know the average amount of incapacity per man in weeks while he has been entitled to compensation, that is to say, after the first two weeks. Call it \hat{w}_x for the former, and w_x for the latter. Then at age $x+n$ the values of the benefits will be respectively—

$$(20) \quad v^{n+\frac{1}{2}} {}_n p_x \hat{w}_{x+n} \times \frac{1}{52}$$

$$(21) \quad v^{n+\frac{1}{2}} {}_n p_x w_{x+n} \times \frac{Q}{52}$$

And for the whole of life

$$(22) \quad \frac{\hat{S}'_x}{D_x} = \frac{1}{52} \cdot \frac{v^{\frac{1}{2}} (D_x \hat{w}_x + D_{x+1} \hat{w}_{x+1} + D_{x+2} \hat{w}_{x+2} + \&c.)}{D_x}$$

$$(23) \quad \frac{S'_x}{D_x} = \frac{Q}{52} \cdot \frac{v^{\frac{1}{2}} (D_x w_x + D_{x+1} w_{x+1} + D_{x+2} w_{x+2} + \&c.)}{D_x}$$

If the benefits are to cease at a fixed age, after which it is assumed the workman will be superannuated, we shall have for the temporary expressions

$$(24) \quad \frac{\hat{S}'_x - \hat{S}'_{x+n}}{D_x}$$

and

$$(25) \quad \frac{S'_x - S'_{x+n}}{D_x}$$

As regards our own country it is not, perhaps, necessary to

distinguish between temporary total incapacity and temporary partial incapacity. If a workman is able for only half his ordinary work, and is entitled, during four weeks say, to half his ordinary wages, he may, it would seem, be counted as having been totally incapacitated during two weeks. In that case formulas 21, 23, and 25 may be dispensed with.

Collecting now the different portions of the problem we have been dealing with, we have for the annual premium, payable throughout life, or for a fixed number of years, for an assurance of the benefits to be secured in case of accident, under our own Workmen's Compensation Act, 1897, to a workman, presently unmarried, if he is injured, (1) at any time throughout life, or (2) before a fixed age,

$$(26) \quad P(b)_x = \frac{s\{3K(b)_x + \ddot{V}(b)_x + V_x + \dot{S}'_x + S'_x\} + 10G(b)_x}{N_{x-1}}$$

$$(27) \quad {}_n P(b)_x = \frac{s\{3(K(b)_x - K(b)_{x+n}) + \ddot{V}(b)_x - \ddot{V}(b)_{x+n} + V_x - V_{x+n} + \dot{S}'_x - \dot{S}'_{x+n} + S'_x - S'_{x+n}\} + 10\{G(b)_x - G(b)_{x+n}\}}{N_{x-1} - N_{x+n-1}}$$

Similarly, if the workman be presently married, we have

$$(28) \quad P(m)_x = \frac{s\{3K(m)_x + \ddot{V}(m)_x + V_x + \dot{S}'_x + S'_x\} + 10G(m)_x}{N_{x-1}}$$

$$(29) \quad {}_n P(m)_x = \frac{s\{3(K(m)_x - K(m)_{x+n}) + \ddot{V}(m)_x - \ddot{V}(m)_{x+n} + V_x - V_{x+n} + \dot{S}'_x - \dot{S}'_{x+n} + S'_x - S'_{x+n}\} + 10\{G(m)_x - G(m)_{x+n}\}}{N_{x-1} - N_{x+n-1}}$$

It will be noticed that formulas (26) and (28), and formulas (27) and (29) differ only in the terms involving K and G and \ddot{V} .

We shall now consider shortly the formulas required to express the benefits provided under the laws of the various Continental countries. These, it will be seen from our table, provide generally in case of death for:—

1. Funeral expenses, whether there are dependants or not.
2. An annuity to the widow of the killed.
3. A payment until a fixed age to each of the children of the deceased, but with a maximum annual amount if there are more than a stated number of children surviving.

4. Some countries give an allowance to illegitimate, as well as to legitimate, children; and in some cases the allowances to the children on the death of their father are increased if their mother be already dead, or dies afterwards before they attain the fixed age.
5. An annuity to the ascendants of the deceased, in most cases qualified by the conditions that the allowance is to be made only either if the deceased leave neither wife nor children, or if the payments to the wife and children do not together exceed a fixed percentage of deceased's wages.

The value of (1) will be simply that of a sum payable at the death of a workman, if that occur as the result of an accident, and may be expressed as follows :

$$(30) \frac{v^{x+\frac{1}{2}}d'_x + v^{x+\frac{3}{2}}d'_{x+1} + \&c.}{v^x l_x} \\ = \frac{(1+i)^{\frac{1}{2}}(C'_x + C'_{x+1} + \&c.)}{D_x} = \frac{M'_x}{D_x}$$

If the assurance is to cease on the attainment of a specified age, the formula will become—

$$(31) \frac{M'_x - M'_{x+n}}{D_x}$$

This is one of the simplest of the benefits we have to deal with, and we need not enter further into it.

In his paper on "Family Annuities" (*J.I.A.*, vol. xxx), Mr. King has dealt with the problem as to the value of a widow's annuity. He shows that, if the wives of husbands aged x are on the average aged y , the value of an annuity to the widow will be given by the integral—

$$(32) \frac{1}{l_x} \int v^t \cdot l_{x+t} \cdot \mu_{x+t} \cdot (ph)_{x+t} \cdot \bar{a}_{y+t} \cdot dt$$

where $(ph)_{x+t}$ is the probability that at the moment of age $x+t$ a male will be a husband. The same benefit expressed in commutation symbols becomes—

$$(33) Y_x = v^{x+\frac{1}{2}} \cdot d'_x \cdot a_{y+1} \cdot (ph)_{x+1} \\ = \text{value of an annuity to his widow, payable only} \\ \text{if the workman is killed by accident in the} \\ \text{year of age } x \text{ to } x+1.$$

$$(34) \text{ And } \frac{W_x}{D_x} = \frac{Y_x + Y_{x+1} + Y_{x+2} + \&c.}{D_x}$$

=value of the same annuity if the workman is killed by accident at any age throughout life after age x .

$$(35) \text{ Also } \frac{W_x - W_{x+n}}{D_x}$$

=value of the widow's annuity if the workman is killed by accident between ages x and $x+n$.

"Family Annuities."

In the paper already referred to, and as its title implies, Mr. King has dealt very fully with the subject of Annuities to children, to begin to run after the death of their father, and to be continued to them until they have survived a fixed age. He has shown that the average values of family annuities may be found for each age at death of married men, when statistics are extensive, by multiplying the average numbers of children in each year of their age left by married men into the corresponding annuity-values and taking the sums. In other words, we require to know the amount on the average that is required, at the death of men of various ages, to provide annuities to the children they leave behind them at specified rates and till fixed ages, just as we require to know the value on the average of the widow's annuity a_{y+1} at the date of death of her husband. The value of a family annuity to be entered on only if the life fail in the year of age x to $x+1$ may, Mr. King shows, be expressed as follows:—

$$v^{x+\frac{1}{2}}(l_x - l_{x+1})(fa)_{x+1}(pm)_{x+1}$$

or, limiting the benefit to the death of the father occurring by accident, we have

$$(36) H_x = v^{x+\frac{1}{2}}d'_x(fa)_{x+1}(pm)_{x+1}$$

If natural as well as legitimate children are to participate, we shall have to introduce a further term, namely $(fan)_{x+1}$ = the value of a family annuity to natural children, and in that case our formula will become

$$(37) H_x = v^{x+\frac{1}{2}}d'_x\{(pm)_{x+1} \cdot (fa)_{x+1} + (fan)_{x+1}\}$$

If an increase of annuity is to be made to the children in case their mother is dead also, we shall have to add to the foregoing formulas

$$(38) + Qv^{x+\frac{1}{2}}d'_x(1-p_y)(pm_{x+1}) \cdot (fa)_{x+1}$$

If a man is already married, $(pm)_{x+1}$ will, of course, become unity in all the above formulas.

If a provision is made for ascendants, as well as for wife and children, the additional benefit to be provided for will in that case be expressed by

$$(39) \quad v^{x+\frac{1}{2}}d'_x \cdot (ps)_{x+1} \cdot (Pa)_{x+1}$$

where $(ps)_{x+1}$ = probability that deceased will leave
parents surviving him,
and $(Pa)_{x+1}$ = value of an annuity to such
parents.

When the Annuity to Ascendants is to be payable only provided the deceased leave neither wife nor child, the formula will become

$$(40) \quad v^{x+\frac{1}{2}}d'_x \{ (1 - (ph)_{x+1})(1 - (pf)_{x+1})(ps)_{x+1} \} (Pa)_{x+1}$$

that is to say, the value of a Parent's Annuity payable if the deceased be at the time of his death neither a husband nor a father, but a son with surviving parents.

It is not easy to see how the provision for Ascendants is to be expressed exactly in those cases where the allowance is to depend on the annuities to wife and children together not exceeding a fixed percentage of deceased's wages. Perhaps it may be sufficient under these conditions to assume that the full percentage of wages will, in all cases, be payable to wife and children, and, over all, the values so increased will, no doubt, fully provide for payments to parents when they become entitled to share in any surplus, after the annuities to wife and children are satisfied.

Where, as in the case of the Danish and Italian Laws, lump sums are provided in lieu of specific Annuities to dependants, the formulas to express the value of the benefit will be the same as (30) and (31) already given for the value of the funeral allowance.

IV.—STATISTICS.

A glance at the formulas we have deduced in the foregoing pages, will show that, in order to their practical application, we shall require to have statistics tabulated on the following points, namely:—

Statistics
required.

- (a) The total numbers employed at all ages in various trades.

- (b) The numbers of Bachelors and married men at all ages.
- (c) The numbers killed by labour accidents at every age.
- (d) The numbers totally and permanently incapacitated by labour accidents at all ages.
- (e) The numbers partially and permanently incapacitated by labour accidents at all ages.
- (f) The numbers temporarily incapacitated, with the duration of the incapacity.
- (g) The numbers of married men who are killed at each age leaving dependants, distinguishing the numbers wholly and those only partially dependent on them.
- (h) The numbers of unmarried men who are killed at each age, and leave dependants wholly or partially dependent on them.
- (i) The wages of the workmen at each age, and the values of the compensations paid under the various headings.
- (j) The relative ages of the widows at the time of death of their husbands.
- (k) The numbers and ages of the children (distinguishing legitimate from natural) left by men killed at various ages.
- (l) The numbers and ages of other dependants left by men killed at various ages.

The last three classes of statistics are required for the calculation of the benefits allowed under various of the Continental Laws.

Having detailed the various statistics that are required, we shall now proceed to enquire how far figures in connection with any of the headings are already available in our own country; and, in regard to those which are not presently procurable, we shall try to indicate the best means to be employed in procuring and tabulating them.

Statistics as to Bachelors and Married Men. We refer, then, first of all, to available statistics as to bachelors and married men, and, in this connection, Dr. Sprague, in his paper on "The Construction of a Combined Marriage and Mortality Table", read before the Institute on 31 March 1879, remarks that the Annual Reports of the Registrar-General and the Census Reports together furnish the means of computing, with considerable accuracy, the rate of marriage among the general population. Though he himself could not

make use, for the special purpose he had in view, of the materials supplied in the Registrar-General's Reports, Dr. Sprague appends to his paper, for the sake of comparison, a table relating to the marriages of bachelors in Scotland derived from the Scotch Census Report of 1871.

Dr. Sprague also refers to an earlier paper, of January 1859, on the same subject, by Mr. Archibald Day. In that paper Mr. Day gives, from the Registrar-General's Returns, the numbers of bachelors and widowers living in 1851, at quinquennial ages, and, from these figures, he derived the probabilities of bachelors and widowers marrying in a year for the same quinquennial ages. Thereafter, by the method of third differences, he interpolated the probabilities of a widower of *every* age marrying in a year.

In his paper on "Family Annuities", Mr. King gave a table which he had prepared from the Census Returns of 1881, of the numbers of bachelors, husbands, and widowers, respectively, per 1,000 males living in each year of age. The arrangement of the table in that way has the advantage of showing at a glance the probability of a man at the moment of death being a bachelor, a husband, or a widower.

We need not refer to other tables of a similar nature, but it will be seen from the foregoing that the returns of the Registrar-General will furnish all the statistics we may require in forming tables of widowers, bachelors, and married men, and for the calculation therefrom of the probabilities of marriage of bachelors and widowers.

Statistics as to Killed by Accident. We shall consider next what statistics are available as to the number killed and incapacitated by accident at each age in the various occupations. Available statistics on this head are not, we shall find, so complete or satisfactory as we should like in the form in which they are furnished.

Early Bills of Mortality. In his paper, read before the Statistical Society in 1881, and to which we have already referred, Mr. Cornelius Walford shows that the Bills of Mortality for the City of London began, as early as the year 1629, to give the causes of death, and he furnishes a table, compiled from these early Bills, showing, among other matters, the deaths in London from accidents during the years 1629 to 1636, and again from 1647 to 1660. Trade accidents are not, however, in any way distinguished, neither are the numbers of the population given for the various years. A table, compiled by Mr. Morris, is also

given of the deaths in London from violence during the years 1675 to 1757 inclusive, as well as the total deaths during these years. Probably no great reliance can be placed upon the figures in these tables, but the regularity in the numbers of accidents from year to year is rather remarkable.

The
Registration
Acts.

Whatever figures may have existed previously, there is no doubt that it is only with the coming into force of the Registration Acts—in 1836 in England, 1854 in Scotland, and 1863 in Ireland—that anything like a satisfactory means of obtaining statistics has been procured.

We do not propose to enter into a history of the development of the Registrar-General's Returns, but it may be mentioned, in connection with our present purpose, that the first return as to violent deaths was given in the report for the year 1838; and since the year 1848 that return has been regularly given each year. Mr. Walford, in his paper, gives a table, derived from these returns of the Registrar-General, of the violent deaths, for each of the years 1838 to 1879 inclusive, of males and females separately, as well as the numbers of the deaths from all causes in these years.

Registrar-
General's
19th Report.

In the nineteenth report of the Registrar-General, the violent deaths for the five years 1852-1856 are analyzed. They are subdivided into six groups—(1) connected with railways; (2) mines (coal and metals separately); (3) mechanical injuries; (4) chemical injuries; (5) asphyxia; (6) violence (not defined). Mr. Walford has compiled a complete table of these deaths, so distinguished, for the years 1852 to 1879 inclusive, and he also gives a table of the total deaths in the same years.

Supplement
to the 55th
Report.

In the supplement to the 55th Annual Report of the Registrar-General in England, Part II, a mass of information is given as to mortality from various causes among those engaged in various occupations.

The information in the report is given largely in the form of "comparative mortality." That is to say, as shown by the census of 1891, 1,000 deaths occurred among 61,215 men of the general population aged between 25 and 65 years of age, these 61,215 being distributed as follows:—

22,586	were aged	25 to 35.
17,418	„	35 to 45.
12,885	„	45 to 55.
8,326	„	55 to 65.

By applying to those four numbers the corresponding rates of mortality for any occupation, the number of deaths is ascertained which would occur among 61,215 men engaged in that occupation, but with the same age constitution as that which ruled in the general population. This number is the

“Comparative Mortality.” “comparative mortality figure” for the occupation on the basis of the statistics for 1890-92. The following tables among others are given in the report, namely:—

- I. For 100 different occupations the numbers living and the deaths at age 15 and upwards; and these figures are then divided into age groups 15-20, 20-25, 25-35, 35-45, 45-55, and 65 and upwards.
- II. The numbers of males dying between ages 25-65 in the same 100 occupations from 24 different causes, including accident.
- III. The “comparative mortality” for all ages between 25-65 in the same 100 occupations, and from the same 24 causes.
- IV. Age constitution of males aged 15 and upwards in various occupations of 1,000 in each case, the numbers between ages 15-25, 25-35, 35-45, 45-55, 55-65, and 65 and upwards are shown.
- V. Comparison of the numbers dying out of 61,215 in various occupations from 13 different causes—accidents among the number—for the 1881 Census and the 1891 Census.
- VI. Deaths of males in 100 different occupations classified according to age and cause. For instance, we have for 100 different occupations the number of deaths from accident stated for ages 15-20, 20-25, 25-35, 35-45, 45-55, 55-65, and 65 and upwards. The total numbers living for these age groups are also given.

For example, as regards the trade of printer, it is shown that for

Ages 15-20 the living were 62,019 and the deaths from accident 21			
„ 20-25	„ 42,969	„ „	8
„ 25-35	„ 55,923	„ „	11
„ 35-45	„ 34,926	„ „	4
„ 45-55	„ 19,530	„ „	9
„ 55-65	„ 8,874	„ „	6
„ 65 and upwards	„ 3,645	„ „	12

From the Registrar-General's Report, it appears that, out of 1,000 deaths among 61,215 men of the general population grouped as to age as before mentioned, 56 died from accident.

Again, the deaths in various occupations among 61,215 men engaged in them, and grouped as already shown, are given. The following are a few examples of the numbers ("the comparative mortality") included in the tables :—

Coal Miner (Monmouthshire and South Wales)	243	Slater	133
Bargeman	223	Manufacturing Chemist .	98
Seaman	202	Boiler Maker	64
Dock Labourer	162	Clerk	21
Coal Miner (Lancashire)	155	Gunsmith	20
Fisherman	148	Draper	19
Railway Guard, Porter, &c.	137	Grocer	16
		Clergyman	9
		Schoolmaster	8

Registrar-General's Returns not serviceable.

We have given details regarding the information as to deaths from accidents contained in the Registrar-General's Reports, but, as already mentioned, these statistics are not directly serviceable for the calculation of premiums for assurance against employers' liability, seeing that they do not distinguish the accidents in connection with occupation from those occurring apart from the occupation, and especially since it has been proved that all workmen are subject to considerable liability to accident outside of their occupation. For most of the information we require it would seem to be essential that we should refer directly to statistics of the various trades to be dealt with, and we shall accordingly enquire next as to materials that are presently available in that direction. Before doing so, however, we may give very shortly particulars as to other information that is available from other official sources.

Returns to Board of Trade of Railway Accidents, &c.

The first of these, we may notice, is the Return to the Board of Trade by Railway Companies of accidents and casualties in pursuance of the Regulation of Railways Act, 1871.

In connection with this Return, it may be mentioned that all accidents which occur in the working of railways, or on railway premises, to persons other than servants of the Companies, are required to be reported to the Board of Trade, no matter how slight the injuries may be; but, as regards servants of the Companies, only those accidents are to be reported which prevent the injured servant from being employed for five hours, on his

ordinary work, on any of the three working days next after that on which he meets with the accident.

Very full details are given in the Return as to the numbers killed and injured of "passengers", "servants", and "other persons" separately. There is also given the character of the accidents, whether by collisions or otherwise, and the extent of the injuries, whether fatal, or resulting in the loss of feet or legs, arms or hands, fingers or toes; fractures of the skull, legs or arms, collar bones, or other bones; dislocations; internal injuries; contusions of head or body or limbs; scalds or burns; sprains; cuts or lacerations; shock to system; and miscellaneous.

As regards "servants", these particulars are given for the various classes of employment, namely, brakesmen, engine drivers, &c., distinguishing "men" and "boys", but not giving otherwise any indication as to the ages of the injured. The total numbers employed in each class are also given.

Reports of
Inspectors of
Mines.

The next Returns we may notice are "The Reports of H.M. Inspectors of Mines under the Coal Mines Regulation Acts, 1887 to 1896, the Metalliferous Mines Regulation Acts, 1872 and 1875, and the Quarries Act, 1894."

In these Returns the total numbers are given of persons employed in coal mines, below ground and above ground, at ages 12-16, and above 16 years of age.

A table of the numbers of fatal and non-fatal accidents from various causes, and the number of persons involved in each accident, is given, but the ages of the injured are not given in this table. A separate complete list of the fatal accidents is, however, given, showing the date and cause of death, name and description of the mine, name of owner, name of person killed, and his *age* and occupation.

Identical information is given for metalliferous mines and for quarries, excepting that the total numbers employed in these occupations are given for ages 11-13, 13-18, and "above 18."

As regards non-fatal accidents, the only information given is the number from each cause, but no details are given as to the ages of the injured or the extent, &c., of their injuries.

Report of
Inspector of
Factories and
Workshops.

In the Report of the Chief Inspector of Factories and Workshops, a table is given of all accidents reported during the year as occurring in factories and in workshops separately. The nature of the injury is shown under the following headings, namely, "Causing Death", "Loss of

“right hand, of left hand, of part of right hand, of part of left hand, of any part of leg or foot; fractures of limbs, or bones of trunk, of hand or foot, loss of sight of one or both eyes, injuries to head and face, burns and scalds, lacerations, contusions, or other injuries not already enumerated.”

The accidents are detailed for males and females separately, but the only indications given as to age are the groupings of the numbers under the headings “Adults (over 18), young persons (13-18), and children (11-14).” No indication is given of the numbers engaged in any of the employments dealt with.

The accidents are also arranged so as to show the numbers applying to each separate industry, and the actual immediate causes of them, whether resulting from hoists, shuttles, cranes, explosions, &c.

The number of cases of lead, phosphorus and arsenic poisoning, and anthrax, are also given for males and females separately, under the three groups of adults, young persons, and children, for various occupations. The numbers employed are not, however, given in this case either.

It has been noticed already that Mr. Neison found the statistics of accidents on railways supplied to the Board of Trade incomplete and altogether unsuitable for his reports; and, from the general idea of their contents given in the foregoing paragraphs, it would seem as if the Reports of the Inspectors of Mines and Factories in their present form were likely to be found equally incomplete and unsuitable for the purposes of actuarial investigations.

Before we pass from Official Reports, we must notice one other publication which is compiled by the Board of Trade. It is called the *Labour Gazette*, and has been issued monthly since the year 1893. Consisting of over 30 pages of foolscap size, it contains an immense amount of most interesting, and varied, and instructive matter, well arranged, on all subjects relating to industry at home and abroad. For instance, the following, among other matters, are dealt with by it:—The state of the labour market for the previous month; wages and prices in various trades in various districts; trade disputes and strikes; changes in hours of labour; diseases of occupations; emigration and immigration; pauperism; legislation affecting labour in our own and other countries; decisions in the Law Courts in connection with actions under Workmen’s Compensation and other Acts; industrial prosecutions; notices

Unsuitableness of
Official Statistics
presently
available.

“The Labour
Gazette.”

of the terms of new laws on sickness, old age, and accident in our own and other countries, &c., &c.

In each issue of the *Gazette* there is also given a table of the industrial accidents reported during the previous month, based on information furnished by the Home Office and the Board of Trade. The numbers of killed and injured are given separately for railways, quarries, mines, shipping and factories, and the numbers employed in each branch according to the latest returns are also given. The ages of the killed and injured are not, however, given. Details of the accidents under each of the foregoing branches are then given. For example, under railways are given the numbers killed and injured among engine drivers, firemen, guards, porters, shunters, &c.; and so for the other branches. For the month of January 1900, the total numbers employed under the various branches referred to is shown to be 5,447,140 persons.

Though the *Labour Gazette* contains so much interesting and useful information, got up in an attractive form, and costs only one penny per month, it is disappointing to learn from the publishers' agents that it is seldom asked for. One feels sure that this is not the fault of the *Gazette*, but that, like many other Government publications, its usefulness is lost to the public because it is not brought in any way prominently before them. We have ourselves more than once before found very great difficulty in learning whether there were any, and what, returns issued by Government on certain subjects. Their own agents out of London have not usually even a list of their publications, and such a thing as a catalogue of Government Blue Books and other issues seems quite unknown in our Public Libraries, where surely such a catalogue ought to be placed for reference. It seems to us that the duty of the Government does not end in simply preparing elaborate and valuable and useful returns, at great cost often. It ought also to see that every facility is given to the public of knowing about these stores, of what ought to be, to very many persons, not only interesting, but serviceable and profitable information.

Other sources
of Statistics
available. We shall now consider what other sources, apart from official publications, are open at present for supplying the statistics we seek; and we shall indicate very briefly the nature and extent of the information which is likely to be available from them.

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Accident
Insurance
Companies.

In the first place, it naturally occurs to us that Accident and Employers' Liability Assurance Companies must, by this time, have accumulated an extensive and reliable mass of facts which, if contributed by them, would form the basis of very useful and important tables. What the extent of this supply may be we have no means of knowing, but, if the matter were fully considered by the Companies, it is likely they would see it to be to their interest to set about some such investigation into their experience, as the Life Assurance Companies have done on more than one occasion. Not only would they, by such an investigation, be furnished with the means of calculating, on a suitable and scientific basis, the premiums to be charged for various risks, but, in setting up such a table as a standard, they would no doubt be taking one of the surest methods of preventing that excessive cutting of rates, and accepting of business at premiums altogether inadequate to the risk, which is so much complained of at present. If, moreover, the experience of the Companies were published, the general public even would soon come to discriminate so far as to avoid insuring in offices which were evidently doing business on altogether unsafe lines. The tendency all round, therefore, of such an investigation, and resulting standard table, would be to secure adequate premiums, and prevent undue and reckless competition.

Industrial
Insurance
Companies.

Besides the purely Accident Insurance Companies, our large and well-conducted Industrial Assurance Companies could, without doubt, furnish pretty extensive statistics as to deaths from trade accidents under policies effected with them. Such statistics are likely to be very reliable, and they could probably be afforded without entailing very great trouble upon the offices.

Railway Benefit
Societies.

Most, or probably all, the Railway Companies in this country have instituted Accident and Benefit Schemes for their employees, and many of them embrace a very large number of men, and have been in existence for many years. Two such schemes are referred to by the Chief Registrar of Friendly Societies, in his Report for the year ending 31 December 1898, as having been certified by him, namely, The Great Eastern Railway Accident Fund, embracing about 24,000 workmen, and a scheme of the London, Brighton and South Coast Railway referring to 13,396 workmen. If the various railway schemes in existence contributed their experience,

a mass of most valuable statistics would be available for computing the necessary premiums to be charged for assurance of railway servants. Such information would be invaluable to the Railway Companies themselves, but it would not likely be of much service to Assurance Companies, as, on the whole, it is likely to be but seldom that Railway Companies, or their servants, will require to seek the guarantee of assurance outside of their own schemes.

Miners' Relief Societies.

Another great branch of industry, with which

Assurance Offices are much more likely to have dealings, is that of mining, and fortunately, in connection with it, there are extensive, and complete, and reliable statistics available for the use of the Actuary. These are to be found chiefly in the Reports of the various Miners' Permanent Relief Societies, which are usually drawn up in a very clear and interesting manner.

At least half-a-dozen of these Societies have been established, and, at a Conference of their representatives held at Manchester in the beginning of the year 1880, it was resolved to found a "Central Association for dealing with Distress caused by Mining Accidents." The objects of this Association are stated to be, to guard against any one Society being overwhelmed through the liabilities brought upon its fund by a serious mining calamity; to open up relief funds in mining districts still unrepresented; to secure uniformity of action in dealing with the risks, and to afford an opportunity for the discussion of matters of mutual interest; to prepare model rules; and, generally, to co-operate with one another for the common welfare.

From the 26th Annual Report of one of the most important of these Societies, namely, the Lancashire and Cheshire Miners' Permanent Relief Society, it appears that its membership at the close of the year 1898 was 41,581, its ordinary revenue £54,499, and its expenditure £63,052, and its funds £118,362. During 1898 there were 8,968 cases of disablement amongst the members, and 75 fatal accidents by which 75 members were killed. These fatal accidents placed on the funds 50 widows and 103 children; and, at the close of the year, 683 widows and 810 children were receiving annuities from the Society, amounting in all for the former to £8,460 (*i.e.*, £12. 8s. each on the average), and for the latter to £4,926 (a little over £6 each). Of the 8,968 cases of disablement, there were 2,647 in which only one week's relief was paid. The report further states that "Representatives of the

“ various Permanent Societies again met in council and decided
 “ to continue the collection of statistics which was commenced
 “ in 1878, and which has proved an exceedingly serviceable record
 “ of the experience of these organizations. The figures showed
 “ that the Associated Miners’ Permanent Societies had, at the
 “ close of 1897, a total membership of 334,428, accumulated
 “ funds amounting to £714,875, and a revenue of £313,480.
 “ On the funds were 3,395 widows, 4,392 children, and, during
 “ the year 1897, there were dealt with 59,507 cases of
 “ disablement.”

Mr. Neison's
 conclusions as to
 Relief Fund
 Statistics.

Mr. Neison has reported on a large number of these Permanent Relief Funds, and, as a result of his examinations of them, he arrives, in his Report of 1880 already referred to, at the following, among other, interesting conclusions :—

That, according to the actual experience of the Miners’ Permanent Relief Funds, the proportion of miners temporarily disabled by accident in the course of a year depends somewhat on the particular mining district, and varies from 1,400 to 1,900 per 10,000 persons employed.

That the average duration of these claims is from three to three and a half weeks each.

That the proportion of miners so seriously injured that their disability exceeds a period of six months varies from 20 to 25 per 10,000 employed.

That the average duration of these claims may be roughly approximated at two years, one-fifth of the claimants ultimately dying from the effects of the accident.

That to every 100 miners losing their lives by accident, 60 will be married men leaving widows, with, on an average, two dependent children each.

From various other reports, it appears that the ages of the widows brought upon the funds has been on the average $40\frac{1}{2}$ years, and the average age of the children, at the death of their fathers, about 6 years.

In his Report of 1886 on the Monmouth and South Wales Permanent Provident Society, Mr. Neison shows that, of every £1 spent by that Society, the proportional parts were as follows :—

	£	s.	d.
Member's Death Allowances	0	1	3
Widows	0	1	4
Children	0	1	0
Disablement Pay	0	13	5
Management	0	3	0
	<hr/>		
	£1	0	0
	<hr/>		

Many other important and interesting particulars might be referred to in connection with these Societies, but enough has been said to make it clear that, so far as mining is concerned, practically all the statistics we require in connection with the Workmen's Compensation Act are to be had, with probably little difficulty, from the records of the Relief Funds.

As showing the recognized importance of the statistics furnished by the Relief Funds, it may be mentioned that the experience of the Lancashire and Cheshire Miners' Permanent Relief Society, for the five years 1892-1896, together with the amount of wages paid by the colliery owners to the members of that Society during the same years, formed the basis of the Government's Estimate as to the probable cost to the colliery employers of the provisions of the Workmen's Compensation Act, 1897. Of course, as Mr. Neison pointed out at the time, the estimate of the Government was erroneous owing to their comparing the wages for each year with the actual relief payments for that year, in place of with the capitalized value of the payments.

It appears, further, from a speech by the Attorney-General in the House of Commons at the time, that it was from the same statistics that the Government derived their estimate as to the pecuniary saving to the employer of the exclusion from the Act of the first two weeks of sickness.

The Miners' Relief Funds had their origin, to a great extent, in the benevolent desire of the colliery owners and others to relieve distress in times of calamity ; but, since the passing of the Workmen's Compensation Act, 1897, the employers in various industries throughout the country have formed themselves into Mutual Associations for assurance against their liability for accidents to their employees, and in course of time such Associations should be able to contribute valuable statistics derived from their experience. As a sample of such Associations, "The Iron Trades Employers' Insurance Association, Limited", may be referred to. It insures the great majority of the Engineers throughout the

Statistics of
Permanent Relief
Funds Basis of
Government
Estimates.

Employers'
Mutual
Insurance
Associations.

The Iron Trades
Insurance
Association.

Kingdom, and also a large number of the Shipbuilders. The extent of its operations may be gathered from the following statements in its last Annual Report, namely, that for the year 1899, the income of the Association amounted to £70,000, and that its insured numbered about 200,000, with a wages bill of nearly £13,000,000. The Report further states that "careful" statistics, showing the experience of each firm, and each class of "Engineering and Shipbuilding, have been, and will continue to" be, accurately kept."

Scottish
Association of
Millers and
Master Bakers.

After the passing of the Workmen's Compensation Act, 1897, the Scottish Association of Millers and Master Bakers decided to inaugurate a Society for the insurance of its members and the members of kindred trades against claims by their workmen under the Act. In the first instance, however, the Council of the Association very wisely resolved to obtain professional and skilled advice and assistance in launching their Society, and they accordingly asked an Actuary (Mr. Archibald Hewat, F.F.A., F.I.A.) "to prepare the" Tables of Rates to be charged, to classify the risks to be under-
"taken by the Society, and to give his general approval to the
"institution of a scheme on the lines indicated in their Report." They also asked a Chartered Accountant (Mr. R. C. Millar) to assist them in the preparation and inauguration of the Society. The outcome has been the foundation of the Employers' Mutual Insurance Association of Scotland, Limited.

Employers'
Mutual
Insurance
Association
of Scotland.

Report of Chief
Registrar of
Friendly
Societies.

The Report of the Chief Registrar of Friendly Societies for the year 1898 includes, for the first time, particulars of the work done under the Workmen's Compensation Act, 1897.

When the Chief Registrar was asked to certify a scheme, he mentions that he directed his attention chiefly to two questions: (1) Would the Employer pay as much under the scheme as he would have to pay under the Act? and (2) Would the workman derive as much benefit under the scheme as he would derive under the Act? As these questions depend to a large extent upon actuarial considerations, it was suggested to the applicants for certificates to schemes that they should have recourse to the advice of a competent actuary in framing the details. The Registrar mentions, however, that many did not avail themselves of this suggestion, and either consulted accountants, or submitted schemes drawn up without professional assistance. From the

1898 Report, it appears that, in connection with contracting out under the Act, schemes affecting over 89,000 workpeople had been certified. The great majority of these schemes no doubt related to private funds, which had been in existence for years before the Act was introduced, and which had been found to work to the satisfaction of both employers and employed.

Messrs. Wm. Denny and Brothers' schemes. Two schemes by Messrs. Wm. Denny and Brothers, of the Leven Shipbuilding Yard, Dumbarton, are specially referred to in the Registrar's Report, and commendation is bestowed on a pamphlet prepared by that firm for circulation among their workmen, "giving information as to the past history of the Accident Fund, which was founded in 1875, and had worked satisfactorily; tabular statistics of its experience; a very clear statement of the provisions of the Act; and a series of tables showing the application of the Act to the risks undergone by the workmen, who were thus placed in a position clearly to apprehend the schemes which were submitted for certificate." The pamphlet referred to gives a detailed list of the accidents which occurred in the shipbuilding yard during the three years 1894-5, 1895-6, and 1896-7. These details include the occupation of the injured (Labourer, Blacksmith, Rivetter, &c.), the weekly pay at date of accident, number of days incapacitated, the compensation actually paid, and the compensation that would have been paid under the provisions of the 1897 Act. During the three years, there were in all 766 accidents, of which four were fatal, and 26 entailed an incapacity of 12 weeks or more.

This example shows that the records of many private schemes also must be able to furnish useful and reliable statistics. We cannot, however, enter further into details of such schemes, even if they were available, but we shall, before passing on to consider how may best be procured the various and full statistics which it is desirable and necessary to have for the proper estimation of the values of the benefits provided for by the terms of our own Workmen's Compensation Act, review very briefly the sources of statistics in some of the Continental countries.

Foreign statistics. Germany. In Germany, Government Insurance being compulsory, the official Reports of the State Insurance Institutions furnish the most detailed information concerning their operations. Statistics on every point of interest are very fully given, as the following figures, taken from a paper by Mr. A. W. Flux, in the *Journal of the Royal Statistical Society*, will serve to show.

These and other figures given by him are taken from a Report, "Statistik der Knappschafts-Berufsgenossenschaft für das deutsche Reich, Berlin, 1897."

We have, then, first of all the following statistics as to the persons insured and the persons relieved:—

	1895	1896
Number of Persons insured . . .	18,389,468	17,605,190
Number of Persons relieved—		
(a) Injured	277,173	327,270
(b) Widows of Killed	29,071	32,982
(c) Children	54,356	60,555
(d) Parents, &c.	1,952	2,141
(e) Wives of Men in Hospital .	8,017	9,050
(f) Children	17,437	19,248
(g) Parents, &c.	218	205
Total relieved	388,184	451,451
Total spent in Compensation . . .	<u>£2,857,720</u>	<u>£2,506,290</u>

The cost of a fatal accident, it is stated, averages 1·92 times that of a non-fatal case.

It appears that the proportion of deaths to employees in coal mines is practically identical in Great Britain and in Germany.

As regards the duration of temporary disablement from accident in coal mines, the following table shows the distribution of the cases:—

Duration	Per-cent	Duration	Per-cent
Not exceeding 3 Months	28·71	3-4 Years	2·24
3-6 Months	17·97	4-5 „	0·75
6-9 „	14·42	5-6 „	0·45
9-12 „	10·49	6-7 „	0·15
1-2 Years	19·56	7-8 „	0·06
2-3 „	5·18	8-9 „	0·02

Again, considering the age of the persons injured, the proportion is found naturally to be heaviest in middle life. For coal mining we have—

Age of Injured Workers	Per-cent	Age of Injured Workers	Per-cent
Under 16	1·5	41-50	19·7
16-20	13·7	51-60	7·9
21-30	27·7	Over 60	1·6
31-40	27·8	Age unknown	·1

Then there is a very interesting table given, of the following form, showing the numbers of cases of accident due to various causes, and of cost of compensation as percentages of the whole number and cost :—

Industry	Risk proper to the Industry		Defects, &c., due to the Employer		Fault of Fellow Workmen		Fault of Injured Person		Other Causes	
	Cases	Costs	Cases	Costs	Cases	Costs	Cases	Costs	Cases	Costs
Coal Mines .	61·7	67·8	0·6	0·7	4·6	4·4	32·9	26·8	0·2	0·3

There are many other interesting and important tables given, but we cannot refer further to them here. Suffice it to say that full statistics of the German experience are available on every necessary point, and are made use of, not only in Germany itself, but also, either directly or for the sake of comparisons, in many of the other Continental countries.

Austria, Italy, and Norway especially have made the German statistics the bases in the first place of their insurance schemes. As they are accumulating experience of their own, however, they are modifying the results obtained by using the German statistics alone.

Austrian Statistics. Austria now publishes yearly, in the official Report, information concerning the operations of its Insurance Institutions. Moreover, each industrial establishment in Austria is required to show, not only the total number of persons employed, but the *total number of hours* of labour performed.

"Complete Workingmen." This number is called the "*Complete Workingmen*", and is used for purposes of comparison with the number of accidents, in place of the number employed merely. Calculations by this method are likely to be much more exact than in others where no account is taken of the hours per day the workpeople are employed, or of days on which they may not be working full time.

French Statistics. The French authorities have followed with great care the course of German Insurance, and their study of the system has resulted in the publication of six large volumes dealing with the various branches of National Insurance, both in Germany and also in Austria. The operations of the French National Insurance Institutions are also published in the Annual Reports of the "*Caisse Nationale des Retraites pour la*

Vieillesse” and of the “Caisse d’Assurances en cas de Décès et en cas d’Accidents.”

It may be proper and useful to give here an account of various tables which are annexed to the French Law of 1898. There are two sets of them: first, those provided by the Minister of Commerce, with the advice of the Consultative Committee, for the purpose of calculating the Mathematical Reserves requiring to be set up by Accident Insurance Companies (see page 535); and, second, those provided by the National Old Age Pension Fund, showing the rates at which Employers and Assurance Companies may purchase Annuities for injured workmen or their dependants from that Fund (see references to this matter on pages 437 and 438).

Tables
annexed to the
French Law.

The first set consists of the following four Tables:—

Table I, giving the Values of 1 to the Widows or Ascendants of Workmen killed by Accident for ages 15 to 101.

Up to age 30, this Table gives slightly larger values than the British Government Females Table, 1883. From age 35 to age 64 it gives smaller values than the British Female Table, but larger values than the British Male Table up to age 64. From age 65, the French Table gives smaller values than either the British Male or Female Tables.

Table II, The Values of Temporary Life Annuities of 1 to children, until age 16.

Table III, Values of a Life Annuity of 1 to the victim of an accident entailing permanent total incapacity.

This Table gives the values of annuities for all ages at *date of valuation* from 12 to 102, and for all ages at the *time of the accident*, from 12 to 65.

For Example: The Value of an Annuity of 1 to a man now aged 35, who has just been totally and permanently disabled, is 13·289.

And the Value of an Annuity of 1 to a man, also now aged 35, but who was totally and permanently disabled at age 25, is 19·406.

During the first fourteen years after the occurrence of the

Select Accident
Tables.

Accident, the Value of the Annuity rises according to the number of years elapsed from the Accident, and thereafter it depends only on the age attained. In fact, we have, we may say, *Select Accident Annuity Tables*, showing the effects of the Accident to continue for about 14 years, during which the value continues to rise, but thereafter depends only on the age attained.

For example—

$a_{\overline{30}} = 14.006$	$a_{\overline{24}+6} = 19.817$	$a_{\overline{18}+12} = 20.780$
$a_{\overline{29}+1} = 16.128$	$a_{\overline{23}+7} = 20.128$	$a_{\overline{17}+13} = 20.810$
$a_{\overline{28}+2} = 17.416$	$a_{\overline{22}+8} = 20.372$	$a_{\overline{16}+14} = 20.835$
$a_{\overline{27}+3} = 18.270$	$a_{\overline{21}+9} = 20.542$	$a_{\overline{15}+15} = 20.838$
$a_{\overline{26}+4} = 18.916$	$a_{\overline{20}+10} = 20.659$	$a_{\overline{14}+16} = 20.838$
$a_{\overline{25}+5} = 19.422$	$a_{\overline{19}+11} = 20.728$	$a_{\overline{13}+17} = 20.838$
&c.		

Again—

$a_{\overline{30}} = 14.006$	$a_{\overline{30}+5} = 18.173$	$a_{\overline{30}+10} = 17.965$
$a_{\overline{30}+1} = 15.893$	$a_{\overline{30}+6} = 18.293$	$a_{\overline{30}+11} = 17.731$
$a_{\overline{30}+2} = 16.939$	$a_{\overline{30}+7} = 18.323$	&c.
$a_{\overline{30}+3} = 17.544$	$a_{\overline{30}+8} = 18.278$	
$a_{\overline{30}+4} = 17.932$	$a_{\overline{30}+9} = 18.153$	

Table IV, Giving the additions to be made to the Reserves in case the Injured should die, either in the 1st, 2nd, or 3rd years, during which the indemnity is open to revision. That is to say, if the injured workman die within the first three years, the provisions for his wife and children will become payable; and the Table gives the additional Reserves that must be made to provide against that contingency occurring during these years, over and above the Reserve required to provide for the annuity to the Injured himself, so long as he may live. The corresponding complement is given for a man who is in good health, not having been injured.

As regards Mortality, Tables I and II are based on the experience of the Old Age Pension Fund, indicated by the letters C.R. ; while Table III is based on a Table indicated by the letters I.C.F., referring apparently to some statistics concerning lives totally incapacitated by accident. The rate of interest assumed in connection with all the Tables is 3 per-cent.

The second set of Tables comprises five separate Tables, which are somewhat similar to those referred to above. They are—

Table V, giving the numbers living at every age, and the values of annuities to wives and ascendants for all ages from 12 up to 102 inclusive.

Table VI, giving the numbers living from ages 0 to 15, and the values of Temporary Annuities to children till age 16 for all ages from 0 to 15.

Table VII is a collection of Select Accident Tables, of the following form, giving the values of annuities on workmen totally and permanently injured by accident, for all ages at date of accident, from 12 to 70 years of age, and for various years elapsed since the occurrence of the accident:—

Time elapsed since the Accident	AGE AT THE DATE OF THE ACCIDENT						
	30 Years			31 Years			32 Years
	Age now	Table of Mortality	Price of a Life Annuity of 1	Age now	Table of Mortality	Price of a Life Annuity of 1	—
0	30	138,336	12·7187	...	...	...	...
1	31	117,982	14·3406	...	...	...	...
2	32	105,828	15·4827	...	...	...	...
3	...	...	...	...	...	...	...
4	...	...	...	...	...	...	...
...
...
...
14	44	76,655	15·8579	...	...	...	...
15	45	75,894	15·5666	...	...	...	...

In the 15th year after the accident the Select Accident Table joins on to Table No. V.

Table VIII, gives the complement of the price of an annuity of 1 which is to be continued to the wife of the

Injured. The values are given for all ages of the Injured for ages 20 to 70, and the Tables are of the following form:—

Time elapsed since the Acci- dent	AGE OF THE INJURED AT THE DATE OF THE ACCIDENT, 30 YEARS								
	Age now of the Injured	Differences of Ages							
		+10 Years		+5 Years		0		-5 Years	
		Age of Wife	Comple- ment of Price of Annuity of 1	Age of Wife	Comple- ment of Price of Annuity of 1	Age of Wife	Comple- ment of Price of Annuity of 1	Age of Wife	Comple- ment of Price of Annuity of 1
0	30	20	9·4048	...	...	...	...	...	...
1	31	21	7·8688	...	...	...	...	...	...
2	32	22	6·7477	...	...	...	...	...	...
3	33	23	...	...	...	...	...	...	...
...
...
...
...
...
...
14	44	34	4·4444	...	...	...	...	...	...
15	45	35	4·4956	...	...	...	...	...	...

From the 15th year after the accident these Select Tables join on to an aggregate Table IX of the same form, but which deals only with the ages attained of the Injured and his wife, and is altogether independent of the number of years elapsed since the date of the accident.

As regards Mortality, Tables V and VI are based on the experience of the Old Age Pension Fund (C.R.). (Table VI is said to be C.R. extended.) Table VII is based on C.R.I. (Table of Mortality of the Caisse des Retraites pour les Invalides.) Table VIII is based on (C.R.) and (C.R.I.) and Table IX on (C.R.).

The rate of interest in all cases is $3\frac{1}{2}$ per-cent.

We shall close this reference to the French Tables by a few examples taken from them, which will perhaps be interesting as well as instructive.

- (a) A workman, aged 30, has been receiving an annual wage of 1,000 francs, and sustains an injury reducing his wages to 750 francs. His pension will be one-half of the reduction, namely 125 francs. What will

be the minimum reserve required for him for the first year?

If he had sustained total and permanent incapacity, the reserve would be
 $a_{\overline{30}} = 14.006 \times 125 + \text{value in Table IV}$
 applicable to such a life, $.9718 \times 1,000$,
i.e., together 2,722.55

If he were an entirely healthy man, the reserve for a similar annuity would be
 a_{30} by Table I = $20.838 \times 125 + \text{value}$
 in Table IV for healthy life, $.0754$
 $\times 1,000$ which together amount to . 2,680.15

Difference = 42.4

One-fourth = 10.6

Adding this one-fourth to the last number, we have 2,690.75
 as the value of the annuity to a man whose capacity for work has been judged to be reduced one-fourth.

- (b) A workman was injured $3\frac{3}{4}$ years ago at age 32, and obtained a pension of 660 francs. What is the value of the annuity?

$$a_{\overline{32+3}} = 15.8794$$

$$a_{\overline{32+4}} = 16.3403$$

$$.4609$$

$$.1152$$

$$a_{\overline{32+3\frac{3}{4}}} = 16.2251 \times 660$$

$$10,708.566$$

- (c) Taking the same example as the last, but suppose the workman only *partially* incapacitated, his wages of 1,000 francs suffering a reduction of one-third in consequence of the accident. He will be entitled in that case to an annuity of one-half of the third = 167 francs.

According to the last example, if he were totally incapacitated, the value of the annuity would be	16·2251
If he were a healthy life, the value of the annuity by Table V would be	18·0031

1·7780

But his capacity for work is supposed to be reduced one-third, ∴ one-third of difference	·5927
--	-------

167 × 17·4104

2,907·5368

- (d) The same workman (totally and permanently injured) has required one-fifth of the capital value of his annuity to be paid to him in money, and that an annuity may be given him for the balance of capital, and which will be continued at one-third to his wife, aged 28½. Required the price.

As before, the value of an annuity of 1 on his life (totally incapacitated) is 16·2251, and the capital of the pension of 660 francs is therefore	10,709
One-fifth of which is	2,142

Leaving for the annuities

8,567

By interpolation for the differences of age of husband and wife we find from Table VIII for the complement of the reversionary annuity	4·9873
---	--------

One-third of which = 1·6624

Add the value of an annuity of 1 to the workman totally incapacitated	16·2251
--	---------

17·8875

and the remaining capital of 8,567
divided by this result gives 478·93
as the required annuity.

We notice only one other source from which statistics as well as information as to the changes in the laws of the various Continental countries, may be obtained,

namely, the Reports of the four meetings that have already been held of the Congrès International des Accidents du Travail et des Assurances Sociales; and the Bulletin du Comité Permanent of the same organization, which has been issued quarterly since the year 1890. These publications have been described as presenting "the most valuable body of literature relating to the question of workmen's insurance that exists in any language."

Having referred to the chief existing sources from which statistics, or certain kinds of them, might be obtained, we shall now suggest means by which the same statistics, and others which are not presently available, might be regularly and satisfactorily procured hereafter.

We have seen that, in all the Continental countries, the Laws relating to workmen's compensation for accidents require that notice of the accident should be given to the authorities within a certain number of days of its occurrence. Though there is no such requirement in our own Act, yet, according to the Notice

of Accidents Act, 1894, "where there occurs in any employment to which this Act applies, any accident

"which causes to any person employed therein either
 "loss of life or such bodily injury as to prevent him, on any one
 "of the three working days next after the occurrence of the
 "accident, from being employed for five hours on his ordinary
 "work, his employer shall, as soon as possible, and, in case of
 "an accident not resulting in death, not later than six days
 "after the occurrence of the accident, send to the Board of
 "Trade notice in writing of the accident, specifying the time
 "and place of its occurrence, its probable cause, the name
 "and residence of any person killed or injured, the work on
 "which any such person was employed at the time of the
 "accident, and, in the case of an injury, the nature of the
 "injury."

In case of default in giving notice, a fine not exceeding 40s. shall be exigible.

The employments to which the Act applies are as follows:—

1. Construction, use, working, or repair of railway, tramroad, tramway, gaswork, canal, bridge, tunnel, harbour, dock, port, pier, quay, or other work authorized by any local or personal Act of Parliament.
2. Construction or repair, by means of a scaffolding, of any building which exceeds 30 feet in height, or use

or working of any such building in which more than 20 persons, not being domestic servants, are employed for wages.

3. Use or working of any traction engine, or other engine, or machine worked by steam in the open air.

Besides the foregoing, the Board of Trade may extend the Act to any other employment in which 20 or more persons, not being domestic servants, are employed by the same employer, when they are of opinion that such employment is specially dangerous to life or limb.

Fatal Accidents Inquiry (Scotland) Act, 1895. Again, the Fatal Accidents Inquiry (Scotland) Act, 1895, provides for a public enquiry in the case of death from accident of the employer or of his employed, in any industrial employment or occupation in Scotland. The Procurator Fiscal, "as soon as he receives information of the death or deaths" is to proceed to collect evidence and present a petition to the Sheriff craving him to hold a public enquiry.

It would seem that the Government might very easily extend these existing Acts, and require, without entailing much inconvenience, further particulars to be furnished, from which the statistics we seek might be gathered.

A more direct way of getting at the desired information would be for Parliament to pass an Act, similar to that passed in former years in connection with the collection of statistics from Friendly Societies, requiring employers in various trades to keep a Register of their employees, of the accidents occurring to them, and of all other requisite particulars.

The policies of Accident Insurance Companies usually require the employers insured by them to keep proper wages or account books, in which must be entered each week the names of all workmen and sub-contractors employed by the Assured, and the wages and salaries paid to them. The Mutual Insurance Associations, no doubt, require similar or even fuller records to be kept, and it would probably, therefore, entail only a very little extra trouble upon the employers to require them to keep a full record of particulars such as we would suggest. The Register required to be kept by the employer might be somewhat of the following form :—

It would be impossible in most cases to obtain information from employers regarding accidents and compensation paid in *past* years ; but there would appear to be no reason why such particulars should not be regularly and fully supplied by them in future. The employers will, no doubt, readily see it to be to their own interest to supply the statistics required, and it may be that, after a few years' experience has been accumulated, it may be possible to relax the amount of the requirements in this direction.

**The only
satisfactory
source of
Statistics.**

However any existing data in this country may be made use of in the meantime, there is no doubt that it is to the collection and arrangement of fresh statistics, supplied directly by the various trades concerned, that we must look for the compilation and preparation of satisfactory Tables for estimating the values of the various benefits provided under the Workmen's Compensation Act. To be full and satisfactory, such statistics will require to be procured through the medium of the Government, in some form or other, and it is very desirable that those interested in the matter should press for the collection of the necessary data being begun with as little delay as possible.

V.—ACCIDENT INSURANCE.

In the Laws of several of the countries with which we have dealt, there are certain specific regulations and conditions imposed upon Accident Insurance Companies in the conducting of their business. These regulations will not be of interest to all who read these pages, and, on that account, and also with a view to avoid unduly swelling the particulars already given, we have not included them under the different countries. We have thought it well, however, for the sake of those who may be interested in the subject, to give some information regarding them under this separate heading.

To begin with, it may not be out of place to refer in a few sentences to the rise, and the present position of, Accident Assurance in our own country, at any rate.

**Rise of
Accident
Insurance
business.**

It would seem to have been in the year 1845 that personal Accident Insurance took its rise in Britain.

At first, the Companies confined themselves to assuring against Railway Accidents, and it was only in the year 1850 that general accident business was undertaken. In their earlier years, the Companies had apparently no fixed rates of compensation for

accidents. The Company which practically originated the business had in its first Act of Parliament the following clause in regard to the amount of compensation to be allowed:—"The amount to be paid should be deemed as reasonable and liberal compensation for such injury, as well as for the pain of mind and body, and the loss of time and money consequent thereon." It was soon found, however, that such indefiniteness, which was no doubt intended to leave the way open for liberal dealing, was liable to be taken advantage of, and was likely to promote litigation. Accordingly, rates of compensation were soon fixed, and incorporated in the Policy.

**Early
Computation
of Accident
Premiums.**

It is interesting to find that the Company which first started General Accident Assurance business in 1850, consulted Mr. Ansell and Mr. Ryley in regard to the rates that should be charged, and that these gentlemen prepared a scale of premiums for the Office. Some years afterwards Mr. Walford and Professor de Morgan made an investigation into the past experience of the Company, and revised the rates of premium, and re-classified the risks. The rates and benefits thus arrived at seem to have continued unaltered thereafter. Those made use of by the Accident Insurance Companies at the present time seem to be practically the same as those calculated in these early days by Mr. Walford and Professor de Morgan.

**Beginning of
Employers'
Liability
Insurance.**

It was only after the passing of the Employers' Liability Act, 1880, that Employers' Liability Insurance was initiated. It is impossible to say how the rates of premium hitherto charged under this branch of the business have been arrived at, but they have evidently not been founded on any very reliable data.

In 1882, Mr. Walford remarked that, after watching very carefully the proceedings, and after having been consulted by several Employers' Liability Companies on various points, he could not account for the principles, if any principle is involved at all, on which these Companies are conducting their business. He should say that, if they come out of it well, it will be more by good luck than by good judgment. Some of the wildest things he had ever known in modern times have been done by the managers of Employers' Liability Companies.

Only about a year ago the Chairman of one of the leading Companies stated, at their annual meeting, that they had adopted rates of premium for their Liability Assurance business after consultation with the most important Companies.

[These Companies, it is understood, appointed representatives to form a Committee for the purpose of endeavouring to fix the rates of premium that should be charged for various classes of risks.]

And he went on to remark, "It is impossible that we can say 'whether the rates are right or wrong till after twelve months' working of the Act. Having worked with other Companies, we have taken care to have ample and full rates, and, if experience shows us that we are too high, we shall reduce these rates; but if, on the other hand, we find that they are too low, we shall raise them. But it would have been unwise in our *ignorance* to run any risk in making our rates too low." It would seem, therefore, that even yet there has not been any advance in arriving at the proper premiums to be charged for Employers' Liability Insurance, or much improvement in the methods of conducting that class of business.

Competition in Employers' Liability Insurance Business. When it is mentioned that, during the year 1898, no less than 51 new companies were projected to transact business under the Workmen's Compensation Act, the statement that the "competition for business has been most keen" will readily be believed. In addition to new rivals, the Insurance Offices have had to contend also with the Mutual Insurance schemes which have been started in various trades, and to which references have already been made.

Various Expedients adopted by the Companies. At first, an attempt was made to form a tariff among the majority of the leading Offices, but the competition of non-tariff Companies soon led to its abandonment.

In view, however, of the severe competition for business, and the great uncertainty as to the proper premiums to be charged, various devices have been resorted to by the Offices in order to secure assurers, and yet at the same time to safeguard themselves.

"Large employers", we are told, "are given the opportunity by many Companies of effecting insurance on a profit-sharing basis—that is to say, the Offices charge a certain premium, and, after paying the claims and the cost of settlement, they deduct 15 per-cent for expenses and 10 per-cent for profit to the Office, and return the balance to the employers."

Again, "The employers may pay a smaller premium, and retain part of the liability at their own risk, so meeting the views of those who object to the payment of large premiums, but at the same time hesitate to incur the full responsibility thrown upon them by the Act of 1897."

In order to attract colliery proprietors and other similar employers, and for the purpose, at the same time, of sharing what has been termed "catastrophe" risks, various combinations of Offices have been formed with more or less success.

From the foregoing statements, it will be seen that the condition of Accident Assurance business in this country is in anything but a satisfactory condition at present. The premiums have, it is to be feared, been arrived at simply by guess, and without much idea as to whether they are too little or very much too large for the risks incurred. Moreover, as the law at present stands, there is little or no check upon the mushroom companies which are rising in all directions. They are not required, as the Life Assurance Companies are, to publish their accounts, or to make returns as to their liabilities. By charging very low, and, to all appearance, quite inadequate rates, they may manage to gather money enough to keep them going for a year or two, and it will no doubt be only after the crash comes that special legislation will be introduced to regulate the business. Mr. Walford has remarked that "at first young Accident Companies have an immunity from claims, but in about the third or fourth year they feel the pinch." He further observes that "the real question in Accident Insurance is the non-fatal, and not the fatal claims, and these two classes do not bear any relation whatever to one another."

On another occasion Mr. Walford observes that the experience "of Accident Insurance Companies in the class of business which they undertake, and with the classes they ordinarily insure, is that out of every 100 claims, there is about one fatal injury, and 99 non-fatal."

In connection with the statements in the previous paragraphs, the remarks of Mr. C. H. Green, in a paper read before the Insurance Institute of Yorkshire on 26 January last, may be appropriately quoted. He says, "If I were asked to summarize the history of this crisis I should say: At the outset, all the Companies prepared to act in accordance with the spirit of the Act. Fear of competition induced one or two of the Offices to hold aloof, so that they could secure business by accepting slightly lower rates. Their action, coupled with the misleading statements and advice of at least one member of the Government, necessitated the withdrawal of others, and the result has been that rates have been reduced below those at which the spirit of the Act can be honestly carried out, and

“ legal ingenuity has been called upon to assist in whittling away
“ the benefits originally intended to be given to the workman,
“ and advantage has been taken of his ignorance, wherever
“ possible, to make the business pay by depriving him of that to
“ which he was entitled. Truly, a serious charge to lay at the
“ door of any Government!” We would add, truly a more
serious charge still to lay at the door of the Insurance Companies!

**Regulation of
Accident
Insurance
Offices abroad.** In view of the unsatisfactory condition of matters in
our own country, it may be useful to consider the
state of matters and the law in this respect in other
countries.

Of the countries we have referred to in the preceding pages,
Germany, Austria, and Norway make compulsory, assurance by
the State, or at least by means of Trade Associations controlled
in great measure by the State, and there is therefore no room in
these countries for private Assurance Companies.

In France and Italy, however, private Accident Assurance
Companies are not forbidden, and we shall examine shortly the
conditions under which such Societies are permitted to carry on
business in these countries.

**French
Regulations.** In France, it will be remembered, the credit of the
Accident Insurance Companies is guaranteed by the
State, and they are in consequence subjected to stringent
Government supervision. For the purpose of carrying out that
supervision, they are put under the control of the Minister of
Commerce, who is assisted in fixing the amounts of the deposits,
and of the reserves to be required from the Offices, and also in
connection with other questions relative to the application of
the law, by a “Consultative Committee.” That

**Consultative
Committee.** Committee consists of 24 members, made up of
2 Senators; 3 Deputies; 4 persons skilled in the law
or statistics of accidents; 3 members of the French Institute
of Actuaries; the Actuary of the Fund of Trusts and
Deposits; a member of the Permanent International Committee
of the Congress of Labour Accidents and Industrial Assurances;
the President of the Tribunal of Commerce of the Seine;
the President of the Chamber of Commerce of Paris; a
Manager of a Mutual Assurance Society against Accidents;
the President of the Syndicate of Assurance Companies at fixed
Premiums against Accidents; a Workman Member of the
Superior Council of Labour; the President of a Syndicate of
Guarantee; the Councillor of State; Director of Labour and

Industry; the Director of the Staff of Accounting and Technical Instruction; and the Chief of the Bureau of the Funds of Savings, Assurance, Pensions, and Co-operation.

With the advice of the above Committee, the following regulations have been made in regard to Accident Assurance Companies:—

- Deposits.**
1. French Societies must deposit with Government
 - (a) For the first year of trading under the present law, 400,000 francs.
 - (b) For the succeeding years, 2 per 100 of the total wages serving as the basis of the assurances during the last year, except that the sum thus calculated must not be less than 400,000 francs, nor more than two million francs.
 2. If the Society, in terms of its rules, assures only workmen of the same or similar employments, the deposit will be—saving the application of the maximum and minimum fixed by the preceding article—one-and-a-half times the value of the pure premiums required to cover the risk of accidents entailing death or permanent incapacity, unless at the same time the premiums adopted by the Society are less than the premiums determined by the Ministerial decree. In that last case, the premiums determined by the Ministerial decree will serve as the basis for calculating the deposit.
 3. In Societies whose rules stipulate that the capital values of all annuities or indemnities provided by the law of 9 April 1898 must be immediately paid to the National Old Age Pension Fund, the deposit will be only one-half of the sum specified according to the case of either of the preceding articles, the minimum being reduced to 200,000 francs and the maximum to one million.

For Foreign Societies, the deposit is fixed on the bases respectively determined by the Articles (1), (2) and (3) with an increase of 50 per-cent, the minimum being in that case 600,000 francs or 300,000 francs, and the maximum three millions or 1,500,000 francs, according to the case.

If the Assurance Society assures only the risks created by the present law; or if it assures only those employed in one trade or in kindred trades; or if it makes its members liable for a

premium double of what is required for their own risk, or triple the premium determined by the Minister of Commerce, the deposit is reducible by one-half.

The interest on the deposit is in all cases payable to the Assurance Society.

Reserves. Besides making a deposit with Government, Assurance Companies having fixed premiums, and Mutual Assurance Societies, are bound from the second year of their working to lay up a mathematical reserve, having for its minimum of value the amount of capital representing the annuities and indemnities required in case of accidents followed by death or permanent incapacity. The capital required is calculated from minimum tables determined by the Minister of Commerce with the advice of the Consultative Committee.

The amount of the mathematical reserve is arrived at each year, with concurrence of the Society, by the Minister of Commerce, and at the time fixed by him. Strict conditions are, moreover, imposed upon the Societies in connection with the investment of the reserve.

Distinct Administration and Accounting for Different Classes of Business. Companies which assure other risks than those resulting from the present Law, or which assure concurrently an analogous risk in foreign countries, must establish, for the operations attaching to that risk in France, an absolutely distinct administration and accounting.

All Societies must forward, immediately on publication, to the Minister of Commerce, *ten* copies of all rules, tariffs, policies, prospectuses and pamphlets distributed or used by them.

Policy Conditions, &c. Their policies ought

1. To reproduce textually Articles 3, 9, 19 and 30 of the law of 9 April 1898 (that is, they must state the indemnities provided by law; that the Injured can demand payment of one quarter of his indemnity in money, or have a portion applied in purchasing a reversionary annuity to his wife; that a revision of this indemnity can be demanded within three years of the accident, if a change in the condition of the Injured occurs within that time; and, that every convention contrary to the present law is null).
2. To specify that any clause of forfeiture cannot be applied against workmen Creditors.

3. To stipulate that the contracts will, of right, be cancelled in the case where the Society ceases to fulfil the conditions fixed by the law.

Copies of
Accounts, &c.,
must be
furnished to
Government.

The Societies must produce, to the Minister of Commerce, at the dates fixed by him :—

1. The detailed annual account of their operations, with financial and statistical tables annexed, in accordance with the Ministerial decree.

The Societies must deliver a copy of that account to every person requiring it on payment of a sum not exceeding one franc.

2. A statement of the wages assured, and of the annuities and indemnities corresponding to the risks dealt with by the present Law; as well as all other statements and written documents which the Minister deems necessary for the exercise of control.

Commissary-
Controllers.

The Societies are put under the permanent inspection of Commissary-Controllers, under the authority of the Minister of Commerce, and can be besides inspected by every person specially delegated for that purpose by the Minister.

The Commissary-Controllers are appointed on the conditions determined by decree of the Minister of Commerce, with the advice of the Consultative Committee. They take an oath not to divulge the commercial secrets of which they become aware in the exercise of their duties. They are specially attached for fixed periods to the Societies of which they have the control.

They verify, at the offices of the Societies, the statement as to the Assured and wages assured, the contracts entered into, the books and accounts, the cash, the calculation of the reserves, and all the elements of control, either in establishing a Society, or in checking the regular execution of the statutes and prescriptions contained in the various decrees attached to the Law.

They must, however, confine themselves to these verifications and checks, and cannot give the Societies any instructions, or forbid any of their operations. They must report all irregularities to the Minister of Commerce, who alone prescribes the necessary redress.

Foreign
Societies must
appoint a
Representative
in France.

Foreign Societies must accredit, to the Minister of Commerce, and to the Fund of Deposits and Trusts, an agent specially appointed for the management of all the operations undertaken by them in France

under this Law. That agent should be domiciled in France, and he will alone represent the Society to the administration.

How the Cost of Supervision is met. The cost of supervision of the Assurance Societies will be covered by a contribution levied upon them.

That contribution will be proportionate to the amount of the reserve or deposit, and will be fixed annually for each Company by decree of the Minister of Commerce.

Special rules regarding supervision, which are very similar to the foregoing, apply also to Syndicates of Guarantee, but it is not necessary to enter into an examination of these here.

Regulations in Italy. We now give a few particulars as to the conditions imposed upon the Accident Insurance Companies by the State in Italy.

Deposits. Here also the Insurance Companies must make a Deposit with the Government, the amount of which must be invested in State Securities.

The initial Deposit to be made before Accident business can be undertaken will be 200,000 lire, and must not in any case be reduced to a smaller amount. To that minimum the Company must add, at the end of each year, the Deposit corresponding to two-thirds of the annual premiums received in the same year from the assured workmen.

When, at the end of any year, there has been a diminution of the premiums, the Society can require a return of a part of its deposit corresponding to the amount of the decrease, but in no case must the deposit be reduced below the minimum of 200,000 lire.

Societies, in order to being authorized to undertake assurances against labour accidents, must lay before the Minister of Agriculture, Industry and Commerce, the certificate as to the deposit having been made, the normal rates of premium, the general conditions of the policies, and the rule by which the premium may be calculated for the risk in every employment.

The normal rate of premium ought to be fixed in such a manner that no workman can be excluded from assurance.

Any modification of the premiums and conditions must be communicated to the Minister, and they cannot be made use of without having first been seen and approved by him.

A copy of the policy submitted to the Minister must be available for the Inspectors and the Insured, and every policy must conform to the approved copy.

If the conditions of the policy be altered without leave, the

Society subjects itself to a fine of from 100 to 5,000 lire without prejudice to the higher penalty inflicted by the penal code. In case of a repetition of the offence, the license of the Society may be withdrawn.

Accident
Business
must be kept
separate.

Societies transacting also other kinds of Assurance must keep the Accident Branch of their business distinct from all the others. They must besides render separate accounts of their accident business to the Minister.

Representatives
of Foreign
Societies.

The representative of a Foreign Society, legally doing business in Italy, must keep beside him all the books, registers and documents relative to assurance against accidents effected in the Kingdom.

When a Society, for any cause, ceases to do labour accident business, it may obtain a return of its deposit on satisfying the Minister of the extinction of every obligation and engagement entered into by it with its Assured.

Various rules are laid down as to the scope of the inspection of the books, &c., of Assurance Societies. An examination of these rules would, however, prove somewhat tedious, and it is, after all, perhaps unnecessary to enter into them.

Rules are given as to the necessary steps to be taken by an employer when he decides to establish a private Assurance Syndicate for his workpeople; and also in the case of the formation of Mutual Assurance Associations.

A full set of rules is given as to the working of Mutual Associations, and conditions are besides laid down in case of their being wound up.

The particulars we have just given will enable a pretty correct idea to be formed as to the extent and character of Government supervision and control in connection with Accident Assurance Companies in France and Italy. We cannot believe that legislation of an exactly similar character is possible or

Amendment of
the Law in
Britain.

advisable in our own country; but we may hope that a modification at least of the law in force with us as to Life Assurance Companies, which has on the whole worked so well and has really been productive of much good in various directions, will be made applicable to Accident Assurance Companies also. In particular, it would seem desirable that Accident Companies and Mutual Assurance Schemes should be required, at their origination, to make a deposit of a fixed amount, to be left in the hands of Government until they have accumulated

a substantial reserve fund; that they should furnish annual accounts to the Board of Trade; and that, where they undertake to pay annuities to injured workmen, they should be required to make a special return, at intervals of not more than five years, of the actuarial value of all such outstanding liabilities. These would seem to be the chief and the most urgent matters requiring to be dealt with, in the first instance, in connection with Accident Insurance Associations; but, of course, any other points which it might be considered desirable to make the subject of legislation might be included at the same time.

Rates of Premium hitherto charged for Liability Insurance. It now only remains for us to refer to the rates of premium that have hitherto been estimated or charged for various classes of risks, so far as these can be ascertained. We should have liked also to refer to the amount of business done by Employers' Liability Assurance Companies before and after the passing of the Act, but, as the Companies nearly all do other classes of insurance as well, and do not distinguish the amount done in the various sections, it seems quite impossible to arrive at even a fair approximation to the amount of business transacted under Employers' Liability from year to year.

In a paper read before the Manchester Insurance Institute on 10 February, 1893, Mr. Frank Whitworth, of the Employers' Liability Insurance Corporation, refers to hearing, at that time, of risks being covered at the following inadequate rates, namely:

Textile risks, 6*d.* per £100 of wages.

Builders and Painters, 2*s.* 6*d.* per £100 of wages.

Quarries, 3*s.* per £100 of wages.

Mr. Chamberlain's estimates as to cost of Workmen's Compensation Act. In bringing forward the Workmen's Compensation Act, 1897, Mr. Chamberlain estimated that the cost, as regards Collieries, would not exceed one penny per ton, and would probably be less. The cost for ordinary weaving or spinning establishments he estimated at between 1*s.* and, at the outside, 2*s.* per-cent on the wages. For the great majority of trades, Mr. Chamberlain believed that 5*s.* per-cent would be the outside charge per £100 of wages.

Rates quoted by Mr. Stanley Brown. In his paper "On Compensation for Accidents to Workmen in the United Kingdom", included in the Transactions of the Second International Actuarial Congress, Mr. Stanley Brown gave "Specimen Rates" charged for Assurances against Employers' Liability as follows:—

	£	s.	d.	
Textiles	0	10	0	per £100 wages
Cabinet Makers (no circular saw risk)	1	0	0	„
Engineers (shopwork)	1	10	0	„
Coal Merchants	2	0	0	„
Railway and General Contractors (excluding the erection of iron work, tunnelling, or blasting)	2	10	0	„
Dock Service	3	0	0	„
Engineers—Bridge Building	3	10	0	„
Stevedores (on Clyde)	5	0	0	„

Of late the rates for Employers' Liability Assurance have, owing to competition, undergone great alteration, as the following instance will show :—A first-class Company was asked for a rate for a certain risk, and quoted 12s. per £100, at which premium it obtained the Insurance. Next year a new quotation was asked, and the Company offered to accept 7s. 6d. in place of 12s. Another Company, however, stepped in, and secured the assurance at 1s. 6d. per £100.

Comparison of Rates formerly and presently charged.

So far as we have been able to ascertain, the following may be taken as average rates of premium formerly charged, and presently being charged, by Offices of good standing, for the several classes of risks, namely :—

Specimens of AVERAGE Rates of Premium for Assurance against Employers' Liability.

Class of Risk	Old Rate per £100 of Wages	Present Rate per £100 of Wages	Class of Risk	Old Rate per £100 of Wages	Present Rate per £100 of Wages
	s. d.	s. d.		s. d.	s. d.
Bakers	8 6	5 6	Farmers	7 6	6 0
Blacksmiths	10 0	7 6	Floor Cloth Works	10 6	7 6
Bleach Works	3 6	3 0	Gas Works	7 6	5 0
Bootmakers	5 6	4 0	Glass Works	8 6	6 3
Brickworks	10 0	4 0	Grocers	4 0	3 0
Builders	16 6	10 6	Laundries	10 0	5 0
Cabinet Works, without circular saw	10 0	7 6	Masons (Monumental)	7 6	7 6
Cabinet Works, with circular saw	17 6	15 0	Plumbers	15 0	7 6
Carpenters	12 6	8 6	Printers	6 6	3 6
Chemical Works	12 6	10 6	Silk Spinners	4 6	3 0
Clothing Factories	4 6	3 6	Slaters and Plasterers	20 0	12 6
Confectionery Works	6 6	3 6	Spinners, Cotton	4 0	2 9
Corn Mills	9 6	7 6	„ Flax	4 0	1 6
Distilleries	8 6	3 0	Tanners	6 6	2 6
Dyers	4 6	2 0	Tobacco Manufacturers	6 6	3 9
Engineering Works	17 6	12 6	Warehousemen	3 0	2 6
			Wine and Spirit Merchants	5 6	3 0

From the above figures it will be seen that the rates for Employers' Liability Assurance have of late undergone very material reduction for almost all classes of risk. Whether the fall in the rates has reached its limit it is impossible to say, but, as it is, the opinion is being freely expressed that business is already being done in many cases at rates which cannot pay the Offices undertaking the risks.

Methods of
Charging
Premiums.

At present the premiums for insurance are universally charged simply upon the amount of wages paid.

That amount is usually estimated from the sum paid for the previous year, and, by the policies of some Companies, the insurance expires when the amount of wages so estimated has been paid. By other Companies, a clause is inserted in the policy that, "if the total wages paid during any year of assurance shall differ from the amount on which the premium has been paid, the difference in premium shall be met by a further proportionate payment to the Society, or by an allowance by the Society off the next annual premium, as the case may be, but, should the Policy not be renewed, such allowance shall, if the Society think fit, be applied to maintain the Policy in force for such further period as shall be covered by such allowance."

It is safe to say that the Insurance Companies are very generally losers under the second arrangement, as they usually find that, when the amount of wages has been underestimated, as they are more likely to be than overestimated, there is difficulty in recovering the short-paid premium. If they are strict on insisting on payment of such short payments, they of course run the risk of policies being transferred to other Offices. This is another objection to collective assurance, which could not occur

Suggestion as
to allowing
Workman to
take his Policy
with him on
changing
employment.

were the workmen assured separately. On the other hand, it might be suggested that, if workmen were assured separately, there would likely be difficulty and trouble incurred in connection with many who make frequent changes, being only employed for a

short time in one workshop, and who either leave of their own accord or are dismissed by the employer after a very short time of service. To meet this objection, the practice which prevails in another country (Italy, I think,) might be adopted with advantage, namely, to allow the workman to take his policy with him on leaving, the master deducting from his last payment of wages the premium for the unexpired portion of the year's risk

still to run. The workman would not, however, be a loser in this way, as he would have this portion of the premium refunded to him by his next employer on handing over the policy to him. Some little adjustments would perhaps require to be made in the terms of the policy if the workman received a higher or lower wage from his new employer, but there would probably be little difficulty in giving effect to such alterations.

Rates Charged by Mutual Insurance Associations. It is difficult to obtain information as to the rates of assessment levied by the various Mutual Insurance Associations of Employers throughout the country, but we may take it that their charges will be very similar to the premiums required for similar risks by the Employers' Liability Insurance Companies. Competition will, no doubt, bring the rates of the Mutual Associations and the Insurance Companies to a very similar level.

In some of the Mutual Associations, as for instance, the Federation of Master Cotton Spinners Associations, "no attempt was made to fix a rate, but a fund was started, to which members might be called upon to contribute, from time to time, in proportion to the number of men employed." This arrangement has, it is said, worked admirably, but, of course, it has scarcely been tried as yet.

The compensations being different under the Laws of various Nations, we can scarcely compare the costs of working of the Law in our own and other foreign countries. It may, however, be of interest to give here such figures as we have obtained in regard to Germany and France.

Costs under German Law. The following table, derived from the German Experience, is given in Mr. Flux's paper already referred to.

Cost per £100 of Wages in Various Trades in Germany.

Class of Risk	Cost 1886-95	Cost 1895	Class of Risk	Cost 1886-95	Cost 1895
	£	£		£	£
Mining . . .	1·807	2·261	Sugar Manufac- ture . . .	1·368	1·640
Quarrying . . .	1·894	2·168	Tobacco do. . .	·133	·132
Iron and Steel . . .	1·040	1·250	Clothing do. . .	·244	·298
Brick and Tile Making . . .	·847	1·149	Building . . .	1·354	1·797
Chemical Industry	1·301	1·555	Well Sinking and Excavating . . .	1·585	2·066
Textiles . . .	·434	·501	Railways . . .	1·238	1·395
Printing . . .	·279	·309			

Premiums
Charged in
connection with
French Law.

The following figures relating to France are taken from a Table prepared by the National Fund for Assurance against Accidents, and appended to the Law of 1898. The occupations are arranged in the Table in groups, which again are subdivided. We give only a few examples of the principal occupations.

Maximum Tariff of Premiums per 100 Francs of Salary to Assure the Risks provided by the Law of 9 April 1898, against Accidents entailing Death or Permanent Incapacity, either Total or Partial.

Occupation	Premium	Occupation	Premium
	<i>Fr.</i>		<i>Fr.</i>
Railways	1.45	Shipbuilding	3.46
Stone Cutting in Workshops	2.96	Chemical Works	2.15
Glass Works . . . . .	.56	Matchmaking . . . . .	.52
Foundries	3.05	Dyeing by Machinery	1.06
Mills	4.95	Paper Mills	2.12
Threshing Machines.	5.43	Tanneries.	1.55
Metal Working in General	1.36	Jute Weaving	2.06
Engineering Works	3.87	Silk Weaving . . . . .	.25
Sugar Refineries	2.99	Woollen Weaving . . . . .	.62
Building	4.39	Distilleries	2.08
Plasterers	4.58	Masons	4.32
Mines	3.92	Carpenters	9.75
Gunmaking	1.70	Printers and Lithographers	.52

Stamping of
Policies for
Employers'
Liability
Insurance.

One other small matter concerning Policies of Insurance under the Workmen's Compensation Act in this country may be referred to. It is, that the Inland Revenue Authorities intimated to the Offices that such Policies could not be considered as Accident Insurance Policies, as defined by the Stamp Act of 1881, and, therefore, that they were not properly stamped with a penny stamp. The Commissioners were of opinion that Policies of insurance in connection with the 1897 Act must be stamped with a sixpenny or ten shillings stamp, according as they were under hand or under seal. Two of the Companies appealed against this requirement of the Inland Revenue Authorities, with the result, however, that the Court decided in favour of the Commissioners.

Concluding
Remarks.

In treating of compensation to workmen for accidents sustained by them in the course of their employment, we have hitherto dealt only with what we may term generally the historical, the scientific, and the purely business aspects of the subject. Most important as these branches of our enquiry admittedly are, they do not include everything, and there is no

doubt that, equally with the legislator, the Actuary or Insurance Official who confines himself entirely to these, and neglects the philanthropic aspect of the question, will fail to grasp, and, therefore, to deal fairly and effectively with, the intricacies of this portion of the great social problem which is now being put forward for the purpose of being worked out, and that by their hands to a great extent.

Life Assurance (both ordinary and industrial) has already done, and is still doing, very much to make the burden of life easier to multitudes of all classes in the community, by guaranteeing that, in the event of the premature death of the bread-winners, those dear to them shall not be left dependent on charity, or to struggle in their tender years against the difficulties and dangers of the world.

Other forms of insurance are contributing to make the way still smoother, by guarding against the loss of property by fire, storms, burglary, &c.

And now, again, insurance is being required to take upon itself the duty of caring for the injured, and for the dependants of the slain in the great army of industry, to which all are indebted, and which is more than ever increasing in numbers, in intelligence, and in influence. The profession as a whole will, no doubt, seek to provide for this, the newest form of insurance, as well as for the other forms of insurance, which, as we have indicated, are likely to be required within the next few years, in the same upright, wise, and benevolent spirit which has actuated it in connection with life, fire, and other forms of insurance which are now established on such firm and trustworthy bases in our midst.

Upon the Actuary more especially, these new forms of insurance will impose very great additional labour and anxiety; and, while he may be apt to be depressed by the thought that his responsibilities in connection with providing against the inevitable misfortunes of his fellowmen are increasing, and will probably still further increase hereafter, he will no doubt at the same time be cheered and stimulated by considering that extended interests are being confided to his care, and that wider opportunities are being afforded him of being of service and benefit to his fellowmen.

VI.—LIST OF BOOKS AND PAPERS.

In conclusion, we shall simply mention the various Books and Papers consulted, and the other sources from which the information given in the foregoing pages has been drawn. They are as follows :—

Acts of Parliament relating to Employers' Liability in this country.
(Published in a convenient form at the office of the Post Magazine.)

Responsabilité des Accidents dont les Ouvriers sont victimes dans leur travail dans les établissements industriels. French Laws, Paris, 1899.

L'Assicurazione degli Operai contro gli infortuni sul lavoro. Italian Laws, Rome, 1899.

Bundesgesetz betreffend die Kranken-und Unfall-Versicherung. Swiss Laws, 1899.

Lov om Ulykkesforsikring for Arbeidere i Fabrikker M.V. Norwegian Law, 1898.

Étude sur la Responsabilité en Matière d'Accidents du Travail dans les diverses législations de l'Europe. P. Hubert-Valleroux.

Transactions of the Second International Actuarial Congress.

Reports by H.M. Representatives abroad on the Laws regulating the liability of Employers in Foreign Countries, 1886.

Foreign Office Report on the Operation of the German Insurance Laws for 1896.

Reports of the Chief Registrar of Friendly Societies for the year ending 31 December 1898.

Annual Report of the Chief Inspector of Factories and Workshops for the Year 1898.

Reports of H.M. Inspectors of Mines and Quarries.

Returns of Accidents and Casualties as reported to the Board of Trade by the several Railway Companies in the United Kingdom.

Third Interim Report of the Departmental Committee on Dangerous Occupations.

Supplement to the 55th Report of the Registrar-General.

Working Men's Insurance. By W. F. Willoughby.

Cost of Compensation for Mining Accidents in Germany. A. W. Flux.

Compensation for Industrial Accidents. A. W. Flux.

The Rate of Fatal and Non-Fatal Accidents in and about Mines and on Railways, with the Cost of Insurance against such Accidents. F. G. P. Neison.

Employers' Liability Act (1880) 'Amendment Bill. Report from Select Committee with Evidence, &c.

Net Premiums for Insurance against Fatal Accident according to Age and Sex. Dr. Wm. Farr.

The Journal of the Institute of Actuaries, especially the following Papers:—

The German Law of Insurance against Invalidity and Old Age.
By T. E. Young.

On the Rates of Fatal Accidents in Various Occupations. By
J. H. Whittall.

On Family Annuities. By George King.

On the Premiums for Assurances against Issue to Widowers,
Bachelors, and Married Men, &c. Dr. Sprague.

Employers' Liability, its History, Limitations, and Extension. C. H. Green.

On the Number of Deaths from Accident, Negligence, Violence, and
Misadventure, in the United Kingdom and some other Countries.
By Cornelius Walford.

Report of the Lancashire and Cheshire Miners' Permanent Relief Society to
31 December 1898.

On the Mortality in certain Hazardous or Unhealthy Occupations.
J. J. M'Lauchlan.

Accident Insurance, with Remarks on Compensation for Accidents to
Workmen. A. Gibbon Thomson.

Employers' Liability. R. K. Mitchell.

Notice of Accidents' Act, 1894.

The Fatal Accidents Inquiry (Scotland) Act, 1895.

The Labour Gazette.

The Insurance Blue Book, Post Magazine and Post Magazine Almanack,
Whitaker's Almanack, Times, Scotsman, &c.

ADDENDUM.

Since our Essay was written, there have been made certain additions to, and alterations upon, the Laws as to Employers' Liability in several countries. Two additional countries, at least, have adopted Laws guaranteeing compensation to workmen for labour accidents, namely, Holland and Greece: the German Law has been amended in certain important particulars; and we have obtained fuller information as to the Laws existing in certain of our Colonies, which we were unable previously to obtain. It is necessary, therefore, in order to bring our information up to date, to refer to these additional matters shortly.

The Law in
Holland.

We have already made reference to the fact that a Law had been introduced by the Dutch Government for the compulsory insurance of workers in certain trades. It is dated 2 January 1901, and is to come into operation at a date to be determined by the Government. The range of occupations coming within its scope is very wide, but farming, gardening, the Mercantile Marine, and sea-fishing are excluded.

A State Insurance Office is to be established in Amsterdam for the purpose of carrying out the insurance prescribed by the Law.

Compensation
under the
Dutch Law.

“The compensation provided by the Act is (in addition to medical attendance, medicine, &c.,) as follows:—If unable to resume work on the third day after the accident, the injured person receives a payment equivalent to 70 per-cent of his daily earnings, such payment commencing from the day after the accident, and continuing during his incapacity, but not for more than six weeks. If still unfit for work at the end of that time, he receives, so long as his incapacity continues, an allowance equivalent, in the event of total incapacity, to 70 per-cent of his daily earnings, and less in proportion if the incapacity be partial only. Earnings in excess of 6s. 8d. per day are left out of account in calculating these and all other allowances under the Act. In the event of death from the accident, the relatives of the deceased receive a burial allowance equal to 30 times his daily earnings. In addition, the dependent relatives receive pensions, varying from 15 to 30 per-cent (but not exceeding in the aggregate 60 per-cent) of the earnings of the deceased. Widows, if they re-marry, and children when they reach the age of 16, cease to draw pensions, but the former receive a sum of money in commutation. Pensions granted under the Law are (save as to any amount exceeding £21. 13s. 4d. per annum) inalienable and protected from attachment.”

Insurance.

The whole cost of the insurance must be borne by the employer, who is forbidden to make any deduction from his employee's wages in respect thereof. The employer may fulfil his obligation to insure in one of three ways:—(1) He may insure through the State Insurance Office; (2) He may become his own insurer, if he deposit adequate security with the State Insurance Office; or, (3) He may transfer his liability to an Insurance Company, provided such Company deposit adequate security with the State Insurance Office.

The Law in
Greece.

The Greek Law is dated 21 February 1901, and applies to workmen employed in mines, quarries, and smelting works. It excludes injuries causing incapacity lasting only four days or less.

Compensation
under the
Greek Law.

The compensation payable under the Act is as follows :—

In case of injury causing total incapacity, an allowance equivalent to one-half of the wages earned by the injured workman at the time of the accident.

In case of partial incapacity, one-third of the wages.

In case of death, an annuity equivalent to three-fourths of whichever of the above allowances was payable to the injured, to be equally divided among the widow and children; or, if there be neither wife nor children, to parents equally between them. If only one person be entitled to the Annuity, its amount shall be equivalent to one-half only of the allowance to the deceased.

The Annuities to widows cease on re-marriage; those to male children on reaching age 16; and those to female children at the expiry of one year from marriage.

In addition, the employer must defray the cost of medicines during the illness caused by the accident, and the expense of medical attendance during the first three months; and, if death takes place after one year, funeral expenses of £2. 8s.

Payment of the
Compensation.

During the first three months, the allowances are payable by the employer alone. After the expiry of that period, one-half is paid by the employer and the other half by the Miners' Provident Fund, which receives certain taxes on mines and quarries, &c., to recoup its expenditure in connection with such cases. The employer may arrange with the Miners' Provident Fund to take over his liability, provided he deposit with that Institution an amount sufficient to cover such liability.

Amendment
of the
German Law.

By a Law dated 30 June 1900, and coming into operation on 1 October 1900, important changes have been made in the German Accident Law.

Formerly, accident insurance was not compulsory for employees receiving over £100 per annum; now the maximum is raised to £150.

Certain new trades and occupations have been brought under the scope of the law, namely, brewing, transport, blacksmiths' and locksmiths' establishments, warehousing, timber felling, window cleaning, and butchering. Seamen on small sailing ships, and on fishing vessels, are also now included.

In future, in cases of total disablement, where the workman has become absolutely dependent on strangers for attendance and nursing, the allowance, in place of being limited to two-thirds of his earnings, will be equal to their full amount. In cases of partial disablement, if the workman is, owing to the accident, and without any fault on his part, unable to obtain employment, a discretionary power is now given to increase his allowance to two-thirds of his previous earnings.

The following alterations are made on the compensation payable to dependants of workmen killed by accidents:—

- (1) Minimum funeral allowance is increased from £1. 10s. to £2. 10s.
- (2) Annuity till age 15 to each surviving child is raised from 15 to 20 per-cent of the father's wages.
- (3) The provisions of the Accident Law, which have hitherto applied only to a father, are now extended to accidents resulting in the death of a female breadwinner.
- (4) Orphaned *grandchildren*, wholly or mainly dependent upon their grandfather, will in future receive, until age 15, an allowance in the aggregate equal to 20 per-cent of his earnings.

[In the future, as in the past, the aggregate of all allowances to dependants is limited to 60 per-cent of the annual earnings of the deceased.]

- (5) In cases of partial incapacity, where the allowance does not exceed 10 per-cent of the man's earnings, discretionary power is now given (to be exercised on the request of the injured workman), to commute the allowance for a lump sum.
- (6) Formerly the wages of an injured workman above £60 were taken account of only to the extent of one-third of such excess amount; now the limit is raised to £75.

- (7) The Boards of Arbitration under the Accident Law are abolished, and all disputes under that law in future will be settled by the Arbitration Boards formed under the Invalidity Insurance Law.

In addition to the Law of 1898 previously referred to, a law dated 3 April 1900, and coming into operation not later than 1 January 1901, has been passed in Denmark for the insurance of fishermen against accidents on board Danish vessels at home or abroad.

Danish Law
for Insurance
of Fishermen.

A special Insurance Institution is to be established under this new law, and, for an annual premium of about 5s. 7d., a fisherman may secure for himself the following compensations:—

A daily allowance from the end of the thirteenth week after the accident until medical treatment has been completed, or disablement be pronounced permanent, or until death results, of about 1s. 8d. during complete disablement, and less in proportion during partial disablement. Once the disablement has been pronounced permanent, there is payable a capital sum of £200 for complete disablement, and less in proportion for partial disablement. In addition, the injured receives 1s. 8d. per day for 13 weeks. The amount of any daily allowance paid pending uncertainty as to the character of the disablement will be deducted from the capital sum payable for permanent disablement.

In case of death, the family of the deceased fisherman receives a capital sum equal to about £139.

If a fisherman is employed for wages by an employer who does not himself actually engage in fishing, he may oblige his employer to refund him any premiums payable for his insurance.

Laws in
British
Colonies.

We have not, we regret, been able to procure so full or complete particulars as we could have wished as to the laws in force in the British Colonies and Dependencies in regard to the compensation allowed to workmen for labour accidents. Most of the Acts on the subject in our Colonies seem, however, to follow very closely in the most essential points the British Workmen's Compensation Acts. Where we have not been able to consult the Acts themselves of certain Colonies, the particulars we have gleaned regarding them have been derived chiefly from the Emigrants' Information Handbooks for the various Colonies published by Government. These handbooks, we may remark, give a great amount of very

useful and interesting information about our Colonies, and will well repay the time expended in a careful study of them.

South Australia. The first of the Australasian Colonies to follow the example of the Mother Country in legislating as to Workmen's Compensation was apparently South Australia. Its Act is known as "The Employers' Liability Act 1884", and it came into operation on 1 January 1885. Its terms are very similar to, and in fact the wording of its sections is in most cases the same as the British 1880 Act. Notice must be given within six weeks, and the action commenced within six months from the date of the accident; or, in case of death, within twelve months from the date of death. The compensation allowed is the same as under our 1880 Act, namely, three years' wages.

Queensland. Two years after South Australia, Queensland brought out its "Employers' Liability Act 1886", which came into operation on 1 January 1887. Here, again, the Act follows very closely the home Act of 1880. The wording of the various sections and sub-sections is identical. Section 2, however, has an additional sub-section 4, which provides that, if the workman caused or contributed to the injury by his own negligence or *unfitness for work*, he shall not be entitled to claim compensation. Notice may be given within *three months*, in place of six weeks, as under the home Act. The amount of compensation is again the same as under the British Act. If the workman is insured against accident, and the employer has contributed not less than one-third of the current year's premium, the sum assured by the Accident Policy shall be deducted from the amount of the compensation payable to the injured workman. Any contract or agreement having the effect of disentitling the workman to the benefit of the provisions of the Act shall, to that extent, be absolutely void and inoperative.

Victoria. The Law as to Employers' Liability for injuries to workmen in this Colony, forms Part III of the "Employers' & Employees' Act, 1890", which came into operation on 1 August 1890, and has for its object the consolidation of various Laws relating to Employers and Employees. Its provisions and wording are, like the Acts of the two preceding Colonies, almost identical with the British 1880 Act, the amount of compensation payable being in this case also three years' wages. By short renewing Acts it has been continuously kept in force until now, but it will expire on 31 December 1900, unless it be again renewed.

New South Wales. On 8 November 1899 a Bill dealing with workmen's compensation for injuries was introduced into the Parliament of New South Wales, but was "thrown out" on third reading. It is almost a copy word for word of our 1897 Act, the only difference in its provisions being that a workman who is partially incapacitated by injury would receive as compensation not more than 50 per-cent of his *loss* of wages.

Tasmania. "The Employers' Liability Acts of 1895 and 1898 regulate the liability of employers to make compensation for personal injuries suffered by workmen in their "service." We have not, however, been able to examine the provisions of these Acts.

Cape Colony. Coming now to South Africa, we have already referred to a note by Mr. McGowan, included in the Transactions of the Second Actuarial Congress, regarding the state of the Law in Cape Colony.

Natal. By the Employers' Liability Act of 1886, Employers in Natal must, under certain "circumstances, make "compensation for personal injuries suffered by workmen in "their service."

Canada. In Canada, the various Provinces have separate Laws, dealing more or less completely with the subject of compensation to workmen.

Ontario. The Workmen's Compensation for Injuries Act of the Province of Ontario is, in the main, similar to the Employers' Liability Act (1880?) in England.

Manitoba. By Acts of 1893, 1895, and 1898, workmen in Manitoba are secured compensation in certain cases of injury.

British Columbia. In British Columbia the Employers' Liability Act (Rev. Stat. 1897, ch. 69) secures compensation for personal injuries suffered by workmen in certain cases.

We regret we have not been able to see any of the Canadian Acts referred to above.

DISCUSSION.

Mr. L. STAHLSCHMIDT said it would no doubt be generally conceded that the subject which was chosen by the Council in the year 1899 for another Brown Prize Essay was well selected. He made that remark because of the greatly increased liability placed upon employers of labour by recent legislation in this and other countries; and because, owing to the nature of the benefits to workmen and their dependants by way of compensation consequent on such legislation, it had become necessary for the actuary to apply his professional acumen in the direction of producing proper premiums for the varied risks, and, perhaps, of making suitable reserves for liabilities; coupled also with the fact that some life offices had already thought it desirable to introduce into their business the insuring of accident risks. On taking up the paper one was at once impressed by its bulk. It covered a great deal of ground, and consolidated the mass of information in such a form as to render it pleasant and interesting reading for the student, and invaluable for purposes of reference.

A remark was made at the commencement of the paper about Common Law favouring "strangers" more than "workmen" in the matter of compensation for injuries occasioned by accidents. The author probably thought it unnecessary to give any explanation of those two classes; but he would remind the members that Mr. Stanley Brown, in a paper read at the Second International Congress of Actuaries, defined "strangers" as "those having no contract of service with the person charged with negligence", and "workmen" as "those having a contract of service with the person charged."

The author dealt first with the laws of England on the subject under discussion, the respective provisions being very clearly set out. Under the heading of "Common Law" on p. 423 it was stated that "'common employment' freed the employer from liability in the event of the injury being caused through the negligence of a fellow workman." He understood, however, that the doctrine of common employment would not free the employer from liability if he had employed incompetent workmen, through whose lack of skill the injury happened. He believed that was based on the ground that the principle upon which the law proceeded was that the employer had a right of selecting the servant employed, and it was only reasonable that, if he chose an unskilled person to execute his orders, he should be responsible for any injury resulting from the want of skill on the part of his servant. The Act to extend the benefits of the 1897 Act to workmen in agriculture, referred to on p. 433, came into operation on 1 July last. It might be interesting to mention that under that Act the expression "agriculture" included horticulture, forestry, and the use of land for any purpose of husbandry, inclusive of the keeping or breeding of live-stock, poultry or bees, and the growth of fruit and vegetables.

On p. 431 the author concisely summarized the circumstances under which an employer was liable according to Common Law and

the Acts of 1880 and 1897 respectively. The corresponding circumstances regarding the amount of compensation payable might, perhaps, with advantage also have been briefly summarized, in order to bring into prominence the following differences: In the event of death (*a*) under the Common Law no compensation could be claimed, the rule being that a personal right of action died with the person; (*b*) under Lord Campbell's Act the executor could raise an action and recover damages, but there was no fixed limit of compensation; while (*c*) under the Acts of 1880 and 1897 the amount of compensation was limited. Similarly, in the event of injury, (*a*) under Common Law there was no fixed limit of compensation, while (*b*) under the 1880 and 1897 Acts there was a fixed limit. Such brief summaries would enable one to apprehend at a glance the general effect and extent of the protection given by those companies which advertise that their policies cover liabilities in respect of all those statutes.

After reading the mass of information collected as to the schemes in vogue in other countries, and trying to carry in one's mind the main provisions, it was very refreshing to come across the table on p. 479, which enabled one so readily to make a comparison. It was also interesting, and he scarcely knew whether to say consoling or regrettable, to learn that the United States, which were so much to the fore in scientific and commercial undertakings, were behind in the matter of legislation regarding compensation to workmen.

Passing to the actuarial portion of the paper, the table on p. 487 gave specimens from Mr. Whittall's paper of the rates of fatal accidents for certain occupations and groups of ages. It was stated that "The rate is usually higher in the first period, falls in the second, and rises again in the other two groups." That statement was not altogether borne out by the specimens given. On referring to the table it would be seen that in column 6 the rate in the first group of ages was lower than in the second in all three cases; while in column 7 in only one of the three cases was the rate higher in the first group of ages than in the second. On referring to the original table in Mr. Whittall's paper, he noticed that that gentleman gave nine more occupations, and although in some cases the rates in the first group of ages were also lower than in the second, generally speaking the converse might be said to hold; and it was interesting to notice that the fact was confirmed if the rates of fatal accidents from the figures given on p. 486 for the trade of printer were taken out. No doubt the author had chosen the three occupations given in his extract to exhibit the marked difference between the rates in columns 6 and 7. Again, the *Q* in formula 19, p. 498, was not identical with the *Q* defined on p. 494. There it represented "the average proportion of liability where the relatives are not wholly dependent upon the killed", while in formula 19 it was the proportion of wages payable in the event of partial incapacity. The *Q* in formula (1) would, he imagined, vary not inconsiderably in every case according to circumstances, and some little difficulty might possibly be found in attaching a value to it. In that portion of the essay, emphasis was laid upon the two main points brought out by Mr. Whittall in his paper, to which he had

referred—namely, (1) that there was a marked difference between the number of fatal accidents which occurred in connection with the occupation and apart from it; and (2) that the liability to accident was not constant for all ages. If one regarded those features, he took it that it would be necessary to compile tables of premiums not only for every occupation coming under the Acts but also for every age. When one considered, in addition, the inevitable complication of the formulas expressing the benefits, one would not unnaturally hesitate to undertake the task of compiling such tables of rates without first satisfying oneself that one had sufficient and reliable data upon which to base the calculations, and such data were at present not at hand. In a well-known financial journal, only a few days ago, the fear was expressed that even the strongest companies were having a rough experience of compensation business, and that rates which might have been adequate during the first year or two of the working of the Act could hardly now be expected to yield a profit, owing to certain causes having been at work towards the enhancement of cost to the insuring companies. In face of such facts they could not but echo the author's statement, that it was very desirable that those interested in the matter should press for a collection of the necessary data being begun with as little delay as possible.

Mr. R. T. THOMSON (a visitor), said that the author seemed to prefer the assessment of rates in accordance with the ages of the workers. If there was a point upon which he was inclined to feel a little amusement it was that. It seemed to him obviously impossible to deal with a large subject, such as the insurance of thousands of workmen, on anything like a scale of rates relating to the different ages. It was well known by those engaged in that class of insurance, that they must of necessity take the wages book as a basis; and if a limit of age was put in the policies it was altogether a fortuitous matter, which had no recognition in law. While on the question of rates, he would like to say, without divulging any trade secrets, that the halcyon days of 1898 had gone, not to return for many years to come. At present each office was doing the best it could, without reference to what other offices were doing. The essayist had very properly said that the Board of Trade returns were utterly unreliable as affording data upon which to base rates. He was quite sure that any office or actuary who dealt with the returns in that way for the purpose of basing rates to calculate the risks under the compensation, would go very far astray. Having regard to the permanent nature of the liability in many cases, it was a very important point to consider how the offices could be expected to deal with that liability. The point also had a bearing upon the numerous mutual associations which had no capital, and not large funds at their back, to draw upon in case of serious accident in the future. He thought it would also be well to bear in mind the importance of some sort of systematic inspection, as in fire insurance, in order to gauge the risk. At present, companies were going on in a haphazard way. It stood to reason that there must be a very great variety of risks, even in the same occupations; and if fire insurance experts thought it advisable to view the risk and have a surveyor's report,

he was certain such an investigation was necessary in this other class of business also. In regard to the question of competition at inadequate rates, a great deal of business was still being done which, if the facts were gone into, could be proved to be doubtful, if not dangerous. That the class of insurance under discussion had not been a gold mine to the companies, might be gathered from the last published reports for the year 1900. Fifty-three companies doing liability business, including some fire and life companies, received a total of about $3\frac{1}{2}$ millions in premiums, which yielded a net profit of about $7\frac{1}{2}$ per-cent. It would be interesting to know how much of that $7\frac{1}{2}$ per-cent was attributable to the compensation business, and how much to the other classes of business being done by the companies. There was the striking peculiarity about the British Act, that it was necessary to have a vast amount of litigation in order to interpret its provisions. The tendency of recent legislation did not inspire one with confidence as to the future. Of course it might be said that it was the very element of uncertainty which was essential in order to induce people to insure, but that argument was unsatisfactory from an actuarial point of view, and struck at the root of scientific underwriting. How could one arrive at anything like even approximate certainty so long as that inherent weakness in the administration of the Act continued? Whilst, on the one hand, the Act had disappointed the fondest hope of its supporters, it had, on the other hand, exceeded the expectation of those who condemned it. The logical outcome of recent legislation was the extension of the Act to all grades of workmen, whether in workshops, mines, or factories. In no other way could the numerous legal difficulties be removed, questions not so much relating to misconduct, as to whether the class of employment came within the scope of the Act. Far outweighing any algebraic expressions was the importance of practical expert experience, and it was only by frequent opportunity of comparing views and opinions that anything like concerted action could be accomplished. Speaking generally, there could be no doubt there was less intercourse between managers of accident offices in this country than in any other class of insurance. After four years' experience of the working of the Act, and twenty-one years' history of liability assurance, surely sufficient data had been accumulated to enable offices to take joint action in the matter of rates, and those questions relating to the business as a whole. At present, disintegrating forces were at work, but consolidating influences were not wholly absent. Attention should also be directed to the question of the importance of security for the payment of workmen's pensions. In one respect the offices were in the position of public trustees, and if it was incumbent upon life offices to accumulate large sums as security for the policyholders, how much also was it necessary that ample security should be given for the due performance of contracts where the interests of both employer and employed were involved. The hope, and indeed the conviction, was cherished that ere long the companies would find it necessary to come together again. Where mutual interests were concerned, and a friendly spirit prevailed, it was most desirable that offices should combine for consultative and

joint action as regards rating, and testing difficult cases arising out of the Act. They had the example of the life and fire insurance offices before them, and it would indeed be regrettable if there were not some in the ranks of the managers of accident offices who would have the courage to lead, where leading was so desirable, and the power to influence the action of most, if not all, the other offices. It was not too much to say that the salvation of that class of insurance lay in the direction of co-operation for mutual council, tariff purposes, and for the accumulation of statistics dealing with the business generally. Whilst they cordially welcomed the valuable researches of actuaries in that department of insurance, and especially the author's contribution to the study of the subject, they feared the time was not yet ripe for the work of the actuary to bear fruit, nor would it be until those engaged in the practice of workmen's insurance agreed upon some common ground of action.

Mr. F. B. WYATT, as one of the adjudicators on the essay, testified to his great appreciation of the work, from which he had gathered a great deal of information. The labour and research expended on the essay were difficult to realize, as he noticed that no less than thirty-five publications, written in no less than seven different languages, were referred to, all of which must have been studied before the essay was written. A most interesting part of the paper was the way in which the author had brought all the facts together. In particular, on p. 479, a synopsis was given of the various benefits granted in different countries. Mr. Stahlschmidt had pointed out that the benefits to workmen in the United States were not quite so liberal as in England. He would also like to point out that in Germany and Denmark thirteen weeks had to elapse before the workman could claim any compensation. The actuarial formulas were very comprehensive indeed. Mr. Thomson had mentioned that the time was not yet ripe for actuaries in connection with the question; but it was such a vast question that he thought they had better be prepared in good time; and he hoped that those who had the practical management of the companies would combine to furnish the data, in order that the actuaries might deal with them hereafter.

Mr. ARCHIBALD HEWAT said that a few years ago he was asked to collect and tabulate statistics, and guide a large trade in Scotland, with some smaller allied trades, to arrive at suitable rates to cover liability under the Workmen's Compensation Act. He framed the schedules, which were returned privately to him. From these he arrived at rates, and gave the necessary professional guidance. The concern eventually developed into a mutual insurance company. In advising them, he insisted upon great caution being used, for various reasons, principally because, being a mutual concern, they had not much money to fall back upon, and also because the business was a specially risky one. He supposed the company was doing fairly well; but he had pointed out to the directors that years of plenty would probably be followed by years of famine, which would have to be provided for.

Mr. C. H. GREEN (a visitor), said the paper undoubtedly dealt with a subject of very great importance to actuaries and insurance

managers at the present moment, and was one which offered facilities for the practical, as well as for the theoretical, worker amongst insurance men. He, therefore, thought it was a pity that the author had not asked some practical insurance official to revise some of the statements he had made in the earlier part of his paper, as he would thereby have been prevented from making some of the slightly misleading, and in one or two instances erroneous, statements which he had unfortunately fallen into through want of that practical knowledge. On p. 431, in the paragraph under the heading, "Differences between Common Law, 1880 Act, and 1897 Act", the last sentence was not only misleading but absolutely wrong. It could be improved, but would not be made perfectly correct, were it made to read thus: "The fact that he had been injured by an accident arising out of and also in the course of his employment, on or in or about the employer's factory, railway, &c., entitles him, &c." Even then the sentence was not accurate, and was slightly misleading to the ordinary man. The importance of those little alterations was one of the vital points in the consideration of the subject, and formed their great difficulty in dealing with the matter. The same fault was apparent in the author's allusion to the compensation payable. Throughout the paper he assumed, for the purposes of calculation, that the compensation could be fixed or that the compensation was fixed for them. But, unlike foreign countries, England had muddled up the Act with the previous Acts and with the common law of the land; and at the present moment, when an accident happened, they were unable to say, whether the person injured was entitled to compensation at all, which Act the man was entitled to compensation under, or whether there was an unlimited liability in respect to it at common law. They were confronted with these difficulties at the commencement of the measure. At that time, insurance companies could be excused for fixing the rates in the way they did; they prepared to deal with the Act in the spirit of the measure. They took it that the words of the Act were ordinary English words with ordinary English interpretations, but such had not been found to be the case; and they were confronted with an Act which nobody could understand, the ramifications of which nobody knew. A splendid illustration of that occurred over the Border about a month ago, resulting in an employer, and, through him an insurance company, being called upon to pay, on behalf of the employer whom they insured, a carter belonging to a railway company who had been collecting goods at their warehouse, with whom they had nothing at all to do. It would be seen, therefore, that in the calculation of the rates of premium, data for the calculations were absent. It was no use when they were asked for a rate to say, "We will give you something else." They must either do the business or let it pass. It was for that reason they were charged with having guessed at the calculations. He thought actuaries were too hard. If the workmen's compensation companies came to them and asked them to name a rate for a particular risk, they replied, "The rate for something else is five shillings." When an employer came to the company and said, "Relieve me of my liability", what were they to do? They must do business or starve; therefore, the

actuaries had no right to charge them with guessing. They had to live, somehow. Actuaries could not tell, any more than they could, what the rate should be, because they had no data. With regard to statistics, the author had taken the statistics of Mr. Neison and other gentlemen, but all these referred to fixed benefits for fixed individuals, and had nothing to do with the working population of a country like England. They had no control over that lack of legislation which allowed the employer in England either to insure or not, and therefore deprived them of the average of the population from which statistics had been obtained. The time, he thought, was not ripe for actuarial knowledge to be called in. It was rather the time when everyone, actuaries and other insurance men, should use their best efforts to force the Government to place them upon a basis upon which business could be conducted in a practical and proper manner. He was sure that when the crisis was over, and the question was looked at in an impartial spirit, it would be found that the accident officials throughout the country, in spite of their faults—and they had many—had done more for the British workmen than legislation had, and had attempted to work with the most abominably constructed Act that was ever put upon the Statute Book of England, and so had tried to do some good for their fellow-creatures.

Mr. A. W. WATSON said that several gentlemen connected with accident insurance companies had that evening given actuaries advice on the question, and had rightly pointed out that they were not at present in a position to deal with the subject. It must, however, be borne in mind that, whilst actuaries were gathering data and using their best efforts to find a basis on which to calculate premiums for the liabilities existing under the Act as at present, it would be found that the persons who were to be benefited by the Act were assiduously working in such a way that before the actuaries had collected their data the risks would be entirely changed. As an example, it would be noticed from the paper that in England the Act provided that compensation should only begin with the third week. It seemed to be a bone of contention amongst some of the industrial classes as to why they were not entitled to their compensation from the beginning of the accident, and there was a certain amount of agitation going on to have what they called that anomaly removed. He had found that in many friendly societies there was a tendency to make the benefit in the first two weeks somewhat less than it was in the succeeding weeks, and the wisdom of the Government in providing that the compensation should not run until the third week seemed thereby to be proved. Only in the last few days he had come across a case of a friendly society of miners, which, by way of staving off an impending insolvency, had provided that only one-half benefit should be paid in the first two weeks of sickness or accident. He was called upon to advise as to the probable effect of that measure. He discovered that out of 1,100 weeks of benefit paid during the past five years, both sickness and accident, but mainly accident, no less than 640 weeks had been paid for claims arising out of the first two weeks of disability; and the result of reducing the benefit to one-half for the first fortnight would have been to cut down the total money cost to the society by rather more

than 25 per-cent. If, therefore, it was found that the Act was hereafter amended in such a way as to bring the compensation into effect from the beginning of the incapacity, then he feared that whatever data might have been accumulated for their particular guidance on the liability at present existing, would be at once swept away, and actuaries would be called upon to deal with an entirely new set of conditions. The circumstance that, whilst they were collecting data, the people whom the Act more nearly effected were using their best efforts to get the Act amended and re-shaped in their interests, was not, he thought, likely to encourage actuaries in any heavy work in that direction. He wished to confirm the impression the author had formed, that there was ground for making a certain amount of reserve for the liabilities. As they understood it, the custom was to provide only for the current risk and restrict the insurance to a term, renewable at the option of the office at the end of the year, or at an increased premium if the office willed it. He thought there was little probability of altering that custom. As Mr. Thomson had said, the only basis upon which it seemed possible that insurance of the working classes could be made was the basis of the wages book. Actuaries had a certain amount of interest in the working of the great Funds connected with railway societies and the like, and there, at any rate, they had an opportunity of impressing their views and experience upon the managers of those Funds; and he found that in one or two large railway Funds there was a distinct increase in the accident liability after about the 50th or 55th year of age. The increase, however, was so far deferred that the proportion of workmen whom it affected was very small in comparison to the whole body, and, therefore, in comparison with the total premium required to cover the risk for the whole society. He thought this special reserve, which would be needed for the whole of the men, would at all times be very small. Considering the very hazy and indefinite nature of the risk, the accident insurance companies were no doubt safe in providing, so far as their practical experience showed them, for a rate of premium which left an ample margin over the current risk. He wished to ask the author what line of thought led him to the conclusion that, as the employer was compelled to compensate the workman for an injury suffered in his service, he should also take upon himself the burden of providing for that workman during his sickness. As he understood the Act, its purpose was to indemnify the workman for that which he had suffered in the service, and he certainly did not see why it should be a necessary outcome of the Act that the employer should have conjoined with his present liability a liability to provide against sickness. Nor did he think that accident insurance companies would welcome the addition of such a liability to the present risk, for of all the difficult liabilities to administer that of sickness was perhaps the most difficult. For the same reason, he asked the author why he considered that an employer should be bound to provide a capital sum of money at the death of the man whether he left dependants or not? In the event of dependants being left there was an indemnity to them for the deprivation of the breadwinner, but if no dependant was left it seemed to him to be rather a hardship upon the employer that he

should have to pay something into a fund upon which there were no immediate claimants. By doing that the employer was penalized for what might not be his fault. With reference to the extremely interesting table given by the author, showing the rise in claimants in various countries, he would be glad to know whether there was any experience to show that, since the introduction of the Act in this country, the great increase in the number of claimants and in the number of injuries predicted before the Act passed had actually come about. He had had the opportunity of seeing the experience of a large railway accident fund, and it was reassuring to find that the claims upon that fund were almost identical in proportion to the numbers at risk in the two years succeeding the passing of the Act with those of the two years previous to that in which it had been passed, and this although the benefits under the Act were considerably greater than those which the men had previously enjoyed. That fact seemed to show that at any rate actuaries should be careful in putting forward theories as to the possible effect of an Act, because there might be underlying considerations of larger weight which were not seen, and which might upset any conclusions that were formed.

Mr. S. G. WARNER thought the future historian of English insurance would find material for an unusually interesting chapter in the last few years' record of workmen's compensation insurance. The position a few years ago, when the Act was on the eve of coming into force, was that a great national experiment was about to be made, the results of which could not be predicted; many ingenious forecasts, however, being made. He would like to know a little more about the process of construction of rates which took place during that period, because he was certain that great research and consideration were devoted to the subject. The question was whether, as the previous speaker had suggested, too much weight was not given to certain considerations which had not turned out to be so important as they were then expected to be. The experience of foreign countries was a very important factor in the consideration of such a table as, for instance, that given in the paper with regard to the working of the German law. The significance of these figures was remarkable, especially because of the class of accidents, and the columns in which the immense increase occurred. The Act began in 1886, and the experience lasted to 1895. On looking at the death claims, it would be found that they began at 7·3, coming down in 1895 to 3·5. Complete permanent disability began at 4·8, and came down to ·9; permanent partial disability rose from 10·6 to 22·4; while temporary disability increased from 5·6 to 14·3. Those figures were held to have very grave significance as indicating that something of the same nature might be expected in England; and no doubt largely under the influence of such considerations rates were drawn up. Those rates did not prove very practicable, for the important reason that certain large and important organizations stood outside of them—common action in any practical sense, therefore, could not be said to exist. Under those circumstances the device mentioned in the paper as profit-sharing was thought of. Considering the experimental nature of the whole business, in the

circumstances, and as a temporary expedient, it was thought legitimate to say to the public, "We do not exactly know what the experience of this business is going to be, so we have fixed our rates possibly rather heavily on the side of safety. But, recognizing that, we will take you, as it were, into partnership with us, and if the experience proves to be very much more favourable than we had anticipated, we shall be willing to make you certain returns." Those who were accustomed to life insurance would be disposed to say that was an unsound policy, for the reason that no compensation could be obtained for the contingency of a bad return or for the existence of an unfortunate experience, while at the same time the profit from the good experience was to be largely given away. He thought there was now a pretty general opinion that the device of profit sharing, however well intentioned and plausible, was not on the whole satisfactory. What had happened? The more sombre forecasts with regard to the experience had not been immediately verified, the consequence being that in certain quarters rates had gone down to an extraordinary extent. Business was largely done at those rates, and the companies which insisted upon having what they considered to be adequate compensation for the risks, practically found themselves out of the business altogether. What would be the experience of the future? It was very evident that, year by year, the class of the community which benefited by the Act was waking up to the privileges it enjoyed, and the best means of enforcing them. Those things did not come to the minds of such a class of people all at once; it required a few years of experience; but, once the thing was grasped, drastic results might follow. Further, all that had yet been done in the way of judicial decisions in the interpretation of this Act was in the direction of widening its limits, so that now much was included under it to which it had never been supposed it would extend. There was also, undoubtedly, the tendency to extend the legislation to other industries, making it far more embracing and comprehensive than it had been, which, when taken in conjunction with the other tendency to interpret the Act as liberally in the interests of the working man as possible, pointed to a large increase of liability and claims. Everything indicated the conclusion that the day of adequate rates was sure to come again, but in the meantime the great requirement was adequate data. This requirement could only be fulfilled by years of experience and by common action. The experience, of course, they must wait for, but it was daily accumulating, and the common action should be taken as soon as and as effectively as possible.

Mr. W. HUGHES, in closing the debate, thanked the author for his interesting, laborious, and, he would have said, exhaustive paper, but that the subject appeared to be inexhaustible. He had been struck with the great courage, zeal and industry which the author must have possessed to persevere in so intricate an investigation when he came to arrange his material and found what the treatment of the subject involved. Problems connected with insurance merely against death by accident were complicated enough, but in cases of compensation for injury the complications increased at a most alarming rate. The author had included in his paper a list of twelve or thirteen different

elements which had to be combined before one could compute the premiums. It seemed to him that nothing could really be done in the matter in an actuarial sense until they were better supplied with data. Most of the data at present available was obviously incomplete and probably honeycombed with inaccuracies, and, until better data should be forthcoming, it would be impossible to arrive at anything like a scientific premium. But when such data were available Mr. Nicoll's paper would be of the highest value to those who desired to pursue the analysis.

The PRESIDENT (Mr. C. D. Higham), in proposing a hearty vote of thanks to Mr. Nicoll for his paper, begged Mr. Green not to think that anyone had censured him. Both Mr. Green and Mr. Nicoll were of the same mind in thinking that until the necessary data were forthcoming a scientific premium could not be computed. Mr. Green should set about getting the data, and could then appoint Mr. Nicoll or Mr. Hewat, if he liked, consulting actuary; meanwhile they could unite in calling the legislature names. He rather wished the author had softened a little, in view of recent disclosures in the *Times*, his favourable reference to the mode in which trades unions are now generally conducted, and he would point out that British colonies had somehow been placed under the general heading of "Holland." Mr. Nicoll, he added, would find a collection of colonial statutes in the British Museum.

The vote of thanks was carried with acclamation.

Mr. NICOLL, in reply, said he still retained a very lively recollection of the kind reception he had met with on a former occasion from members of the Institute, and he would also retain for the future a very pleasant impression of the way in which his latest contribution had been received. Mr. Thomson had said it was almost impossible to go by the ages of the individual workmen in determining the premiums for liability insurance, but he could not at all agree with that. His suggestion was that each workman should have a separate policy, which, when he left one employer, he should take with him to the next. The old employer would require from the workman repayment of a proportion of the premium up to date of next renewal, but the new employer would refund this to the workman. It was shown in the essay that the United States of America have no special laws regarding compensation to workmen for accident, and he had, therefore, considered it unnecessary to make inquiries as to the way in which insurance companies carried on business in that country. The only adverse criticism of the essay had been made by Mr. Green. He was sorry if he had in any way led Mr. Green to look at the subject in a different way from that in which he looked upon it himself. He would, of course, have only been too glad to have had on many points the advice of an expert in liability business, but the difficulty was that, when one was writing an essay for competition, he was not in a position to consult anybody about it. He had tried to state the law as he found it written, and, as Mr. Green had said that he himself could not understand the Workmen's Compensation Act, it would probably after all not have helped matters very much even if he had troubled him or others for advice on certain points. With regard to compensation, it was quite well known that in no single

case could one tell what amount would have to be paid, but the *average* of claims paid in the past could be furnished, and that would be sufficient. From the statistics in the paper they knew what were the compensations for death claims, for total incapacity, and for partial incapacity, in Austria and Germany, and other countries, and the actuary could take these figures and base his calculations on them. If only the actuary could get the information, he could supply the rates which should be used. He still thought he was justified in any criticisms he had made as to the manner in which liability insurance companies had arrived at their rates hitherto. On p. 530 he had quoted the remarks made by officials themselves of leading liability insurance companies, in which they acknowledged that no definite basis had as yet been adopted in arriving at the rates of premium at present in use. Mr. Watson could not understand why he had said that employers should be liable to workmen for sickness, not only through accident, but through all causes. His meaning was that, as the workman was now by law entitled to compensation during sickness from accident, it was natural that he should seek also to be compensated, either by the employer or by the country at large, for sickness from every cause. He believed the day was not far distant when compulsory National Sickness Assurance, as well as Old Age Pensions, in some form or other, would be adopted in this country, and the sooner actuaries began to look into these questions the better. The same speaker also asked why the employer should be liable to pay compensation for injury in every case. The reply was that it was a wrong principle to relieve an employer of the payment of compensation simply because there were no dependants to receive the money. It seems more logical, as in Italy, to require the money in that case to be paid into a central fund, which could be applied towards certain purposes of the law. Through investigating the subject of workmen's compensation he had received a great impulse to study other social questions, and he should like, for his own benefit, to take up on some other occasion, perhaps, the question of sickness and old age pensions also.

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